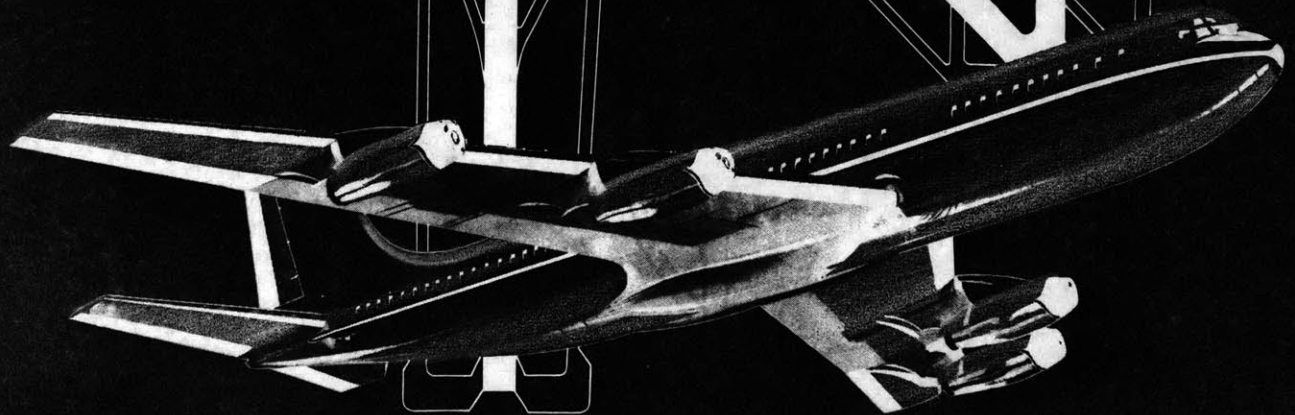
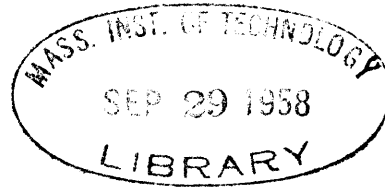


An Air Terminal For

**OKLAHOMA CITY
MUNICIPAL
AIRPORT**

Rex M. Ball - M.I.T.





AN AIR TERMINAL FOR OKLAHOMA CITY MUNICIPAL AIRPORT

A Thesis Submitted in Partial Fulfillment
of the Requirements for the Degree
of
Master of Architecture
at the
Massachusetts Institute of Technology

August 22, 1958

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Rex M. Ball,
Bachelor of Architecture (1956),
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Dean Pietro Belluschi,
School of Architecture and Planning.

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Lawrence B. Anderson,
Head of the Department of Architecture.

214 Graduate House
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August 22, 1958

Dean Pietro Belluschi
School of Architecture and Planning
Massachusetts Institute of Technology

Dear Dean Belluschi:

In partial fulfillment of the requirements for the degree of Master
of Architecture, I herewith submit the thesis entitled, "An Air
Terminal For Oklahoma City Municipal Airport."

Sincerely yours,

Rex M. Ball

ACKNOWLEDGEMENTS

I wish to express my sincere thanks to the following for their patience and criticism in helping me compile this report.

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Dean Pietro Belluschi
Professor Lawrence B. Anderson
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Oklahoma City Municipal Airport

Mr. William Coleman

To:

My father, Ralph Ball, for his advice and enthusiasm.

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TITLE: An Air Terminal For Oklahoma City
Municipal Airport

AUTHOR: Rex M. Ball

This work comprises a study of the requirements for a medium sized air terminal located in a rapidly growing city. Since it is written in the dawn days of the new age of jet travel, emphasis is placed on the integration of passenger convenience and successful airline operation.

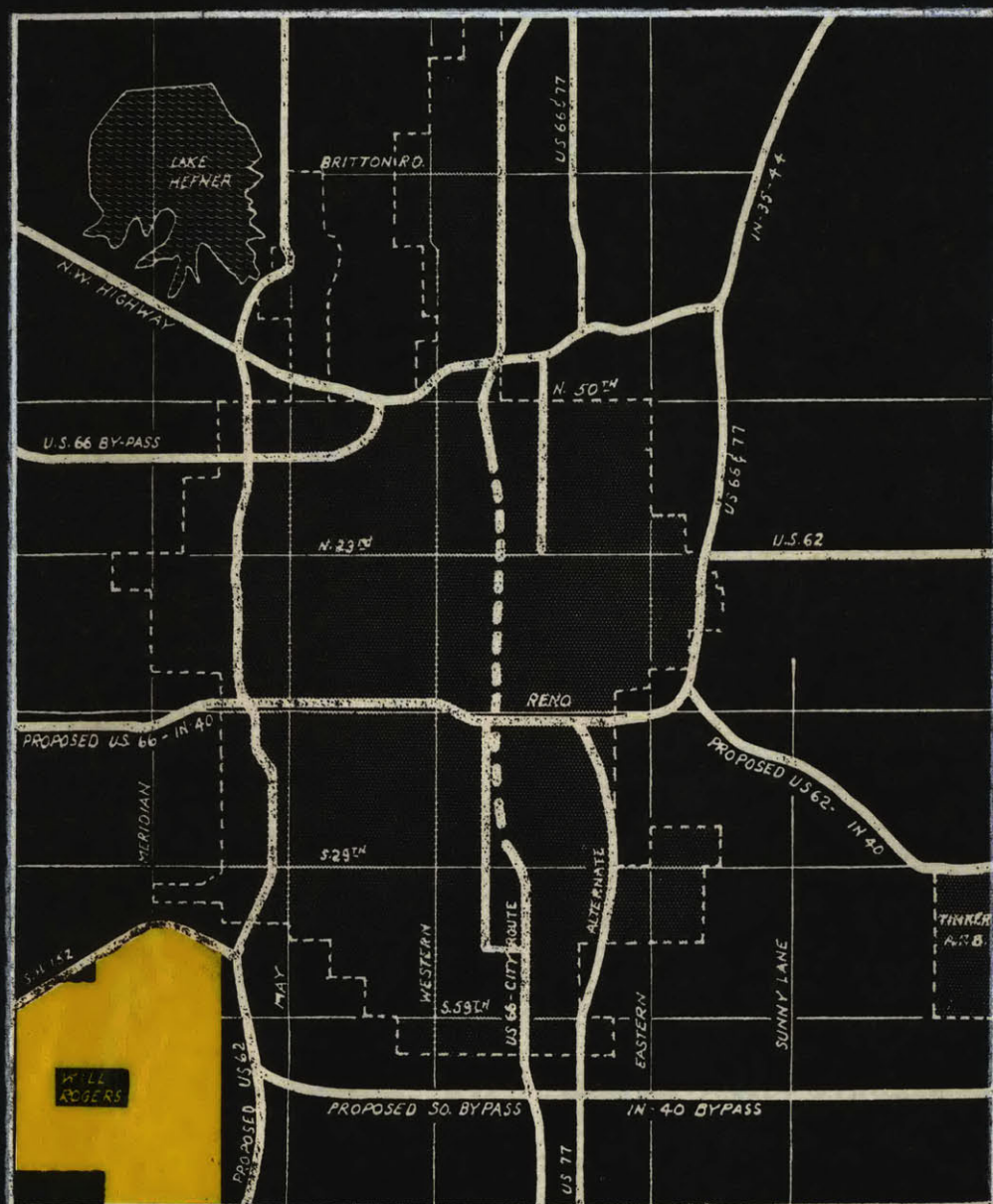
Three words hold the key to air terminal design: circulation, expansion, and flexibility. The degree of success in architecturally uniting these three considerations is the measurement of the design's merit.

The introduction of jet aircraft will radically change the terminal of today. The problems of fueling and maneuvering aircraft, handling passengers and baggage, and controlling exhaust blast and noise require a fresh approach to air terminal operations. The utility of the jet ~~does~~ not depend upon reduced flight time or large passenger capacity, but on speedy ground operations. The terminal design must integrate new solutions into an efficiently coordinated system.

Many schemes have been developed, both by airline executives and by architects who reasonably anticipate the functional requirements of new terminals. The missing elements thus far, however, seem to be architectural--mainly sequence and space. This thesis uses the demands of sequence and space as criteria in defining the circulation.

It is hoped that this study of the changing needs of an airport will help in crystallizing the design of new airports.

THE SITE



Looking West



Looking East

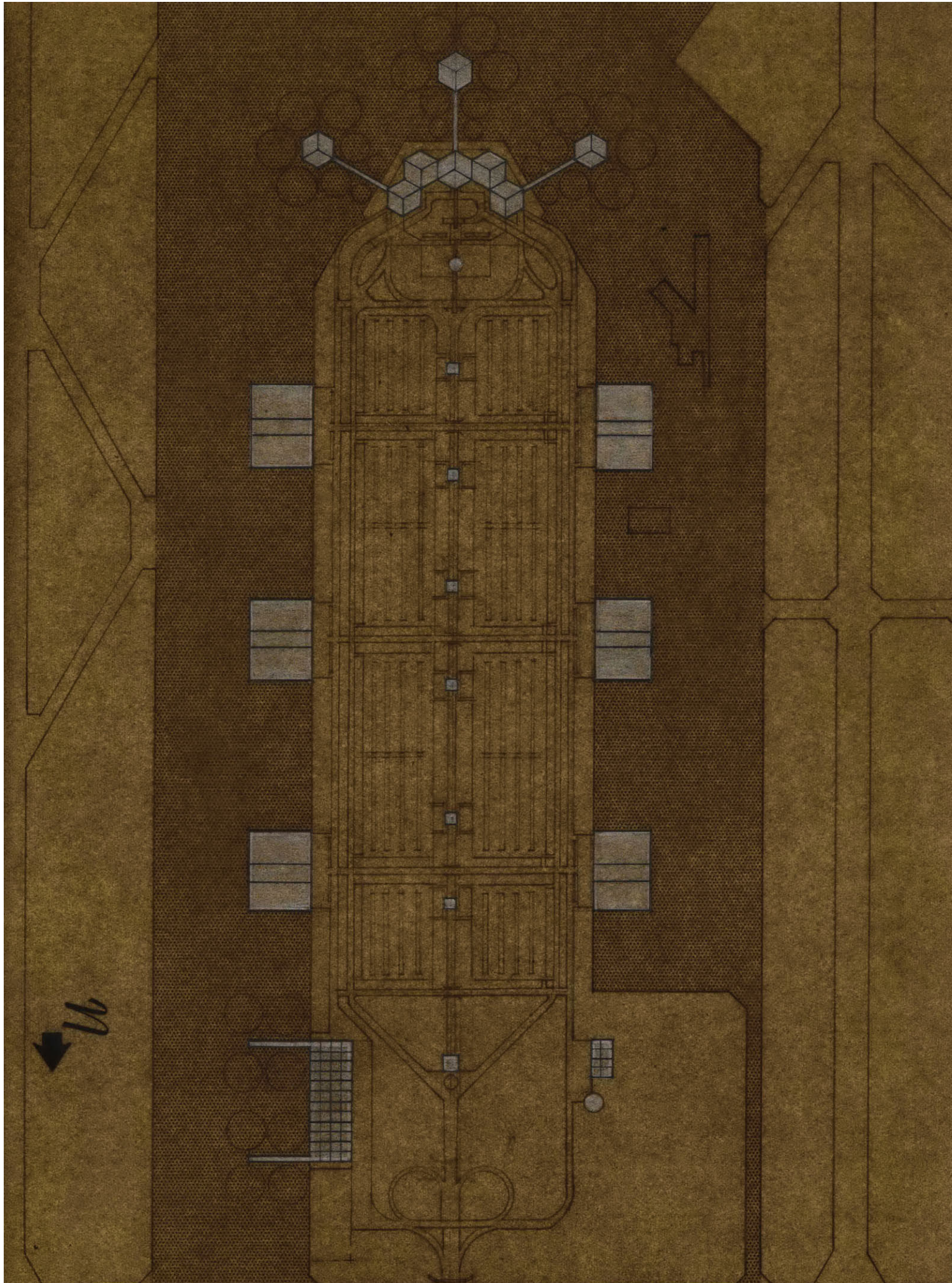


CAA Center



Will Rogers Field





The Key To Growth

The central location of Oklahoma City is its main asset. Located in the center of a state which is located near the center of the country, Oklahoma City easily invited the key to dynamic growth-- rapid transportation. Today it is one of the largest cities in the Southwest. The city was settled on the first day of the Oklahoma Run in 1889. Where there had been a "whistle stop" in the morning, there was a city of tents by night. The location of the city was set at a point in the Great Plains on the North Canadian River, where two railroads intersected. There are four railroads crossing in Oklahoma City now-- the Atcheson Topeka and the Santa Fe, the Rock Island, the Frisco, and the Missouri Kansas and Texas.

Highways

Transportation has continued to play a great part in the development of the city, but since World War II the emphasis has been on highways. The intersection of three major trans-continental highways--U.S. Route 66 (New York to Los Angeles), U.S. Route 41 (East Coast to Los Angeles), and U.S. Route 77 (Chicago to the Gulf of Mexico)--form part of the outer belt of the Oklahoma City Expressway System.

Air and The Future

The future growth, however, particularly as a freight and industrial center, will be determined by combining this existing traffic network with an enlarged air transportation program. The public awareness of this situation was verified recently when a multi-million dollar bond issue was passed to provide for extension of the present runways, new maintenance hangars, and other improvements for handling jet and turbo-prop aircraft. Probably the most significant section of the bond issue authorized the preparation of a completely revised and forward looking master plan. This Master Plan, completed in June, 1958, proposed extension of the boundaries of the present site and made a careful study of the immediate and future needs of the Municipal Airport. Most of the design criteria in this thesis are based upon the Master Plan recommendations.

Predictions

The Civil Aeronautics Administration classifies Will Rogers Field as a "Medium Hub" in the air transportation system, which means that between 25% and 99% of the total number of United States airline passengers are emplaned at this location. The percentage was 41 for 1956 with a total number of 332,812 passengers. This last figure is expected to increase to one million by 1970, and could be greater if provision is made for adequate schedules and terminal facilities for connection to cities with which it has a community of interest.¹ Another source, Pyles Air Passenger Forecast, estimates that 1,222,000 passengers will use the Municipal Airport in 1975. A recent study by the Aeronautical Research Foundation predicts that of the cities studied, Oklahoma City will be fifth in rate of growth and will have a population of one million by 1975.²

Airlines

Five airlines now use Oklahoma City as an emplaning and deplaning point with a sixth currently petitioning to establish service. These are the American, Central, Continental, and Trans World Airlines. Of these, all have announced arrangements to land jet and turbo-prop aircraft in Oklahoma City, and two of these--American Airlines from the East Coast and Trans World Airlines from the West Coast--will terminate jet flights at Will Rogers Field. Combining the above considerations with the fact that experts have always underestimated air travel predictions, a rather ambitious Municipal Airport program for Oklahoma City has been developed.

Site Description

The new Master Plan proposes a system of three major runways, which frame an exceptionally flat rectilinear area to be developed as a Passenger Terminal, Freight Terminal, Maintenance Hangar area, National Guard area, and a central Hydrant Fueling area. The runways are on the east, south, and west and the outer belt of the Oklahoma City

¹Master Plan, Will Rogers Airport, Oklahoma City, Oklahoma, 1958, p.1.

²Aeronautical Research Foundation, Excerpt from "National Requirements For Aviation Facilities," 1956-57, I.V, 32.

Expressway System is on the north. Located on the remainder of the airport property is the CAA Center, "The University of the Air," and several industrial sites. To the north-east of the runway system is a large area for General Aviation (private flying). To the east are several more industrial sites which not only face upon a major north-south runway, but also border the expressway to Tinker Field, one of the largest jet supply and repair bases of the United States Air Force.

Service Separation

The site between the runway system as developed in this thesis is connected to the outer city belt by a six lane expressway. Shortly after automobiles and trucks enter the airport expressway, they come upon a road which joins the General Aviation area and the National Guard area. They then pass under a raised taxiway connecting the two north-south runways. After this point, another bridge is approached which is used to separate service transportation from the traffic using the Passenger Terminal. Hangar employees also use this separation. These service roads lead to the Freight Terminal on the left, the Hydrant Fueling facilities on the right, and to the parking lots bordering the Maintenance Hangars. Each of these roads descends a ramp into the basement of the Passenger Terminal where Air Cargo and Air Express (United States Mail) are loaded and unloaded.

Air Freight Terminal

The Air Freight Terminal is of particular significance, for Oklahoma City has shown signs of becoming a major freight center. It is estimated that 10,000 tons of freight will pass through the terminal in 1970.³ Six transcontinental trucking systems have major terminal bases in the immediate area and their coordination with air traffic will increase in the future.⁴ The building includes warehouse

³Master Plan, chart 9.

⁴Stuart Tipton, "How The Businessman Can Use Air Freight In An Expanding Economy," speech presented before the Chicago Association of Commerce and Industry, Chicago, 1956, p.4.

storage area, preparation area for plane packaging and loading, and administrative offices. The long axis of the building faces the field with plane loading and unloading on one side and truck docks on the other. The trucks can load and unload either at these docks or directly at the plane.⁵ In choosing a loading procedure, consideration should be given to exhaust blast and noise control. A modular construction has been used for the building, providing for ease in expansion and flexibility in adaptation to loading procedures.

Maintenance Hangars

The Maintenance Hangars are of the centrally suspended double cantilever type. The cantilever is 160 feet high, with an unobstructed maintenance area 260 feet in length on each side. Future expansion will present fewer problems with this type of construction, since the hangar roof is self-supporting and additional bays can be built beside the present ones without the need of load bearing walls.⁶

Hydrant Fueling

The Hydrant Fueling System consists of storage and pumping facilities for various aviation fuels. The storage tanks are located on the highest ground in the area, thus providing a maximum flow advantage. To insure safety, however, the tanks are sunken. The pumping station transfers the fuel underground to the exact positions for aircraft servicing. All fuel equipment is eliminated from the field and the fueling process is greatly speeded.

Passenger Roads

As the passenger roads pass the service traffic exit, the roads split and become two four-lane one-way roads. These roads lead to and from the Passenger Terminal and run along the borders of automobile parking lots.

⁵Rotary Lift Company, Proposed Applications, prepared for the City of Oklahoma, Department of Airports, Memphis Tennessee, 1955.

"Loadair," Whiting Corporation Bulletin, Harvey, Illinois, 1953.

⁶"Airports Facilities," Aviation Age, July, 1954.

A Transportation Building is located between the two branching passenger roads. An automobile filling station and garage is also included under the main roof.

Shuttle Bus

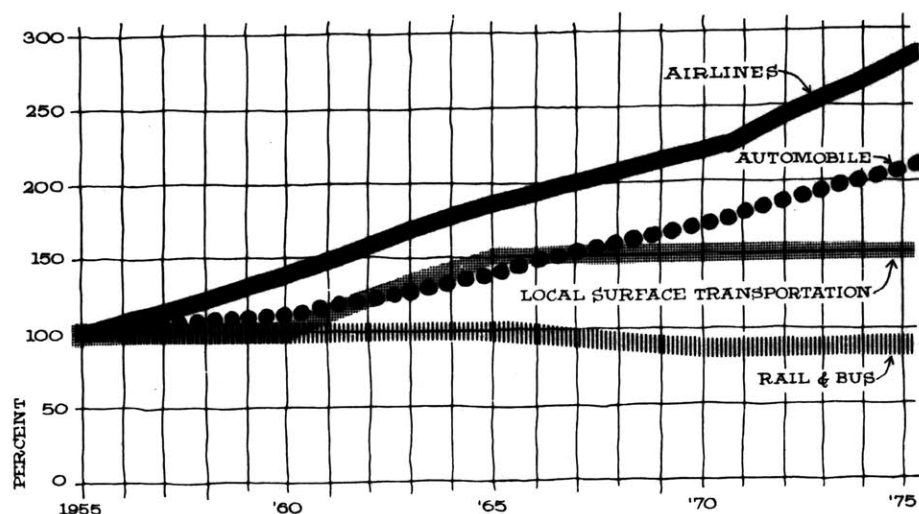
A shuttle bus links the Transportation Building and parking lots to the Passenger Terminal. The road for the shuttle bus begins at the Transportation Building, proceeds down the center of a mall and tunnels under all cross-roads. It finally splits into two one-way roads at the Monumental Fountain. Two covered bus stops are placed at central points between the large parking lots (1,000 automobiles each) and one shuttle bus is located between the smaller lots. Roads are provided for approach to the bus stops so that baggage can be unloaded under cover.

Parking

The eight parking lots, which can handle 5,000 automobiles, are landscaped to appear as green masses from the road. The lots are separated from all roads by a 30 foot green strip. The parking lots nearest the Transportation Building are reserved for air passengers who wish to leave their automobiles at the Terminal during their trip. There will be attendants at these parking lots who can take the car to be serviced while the owner is traveling. This lot has a combination entrance-exit. The lots nearest the Passenger Terminal are for employees. These lots have mechanically controlled gates which only allow the entrance of employees, who, once admitted from there, can either walk or take the shuttle bus into the Passenger Terminal. The remaining lots are for visitors and air passengers' friends and families. These lots will be manned by attendants at two entrances and one exit. The expense of three attendants per lot is justified by the revenue produced by charging the passenger according to the length of time his car is parked.

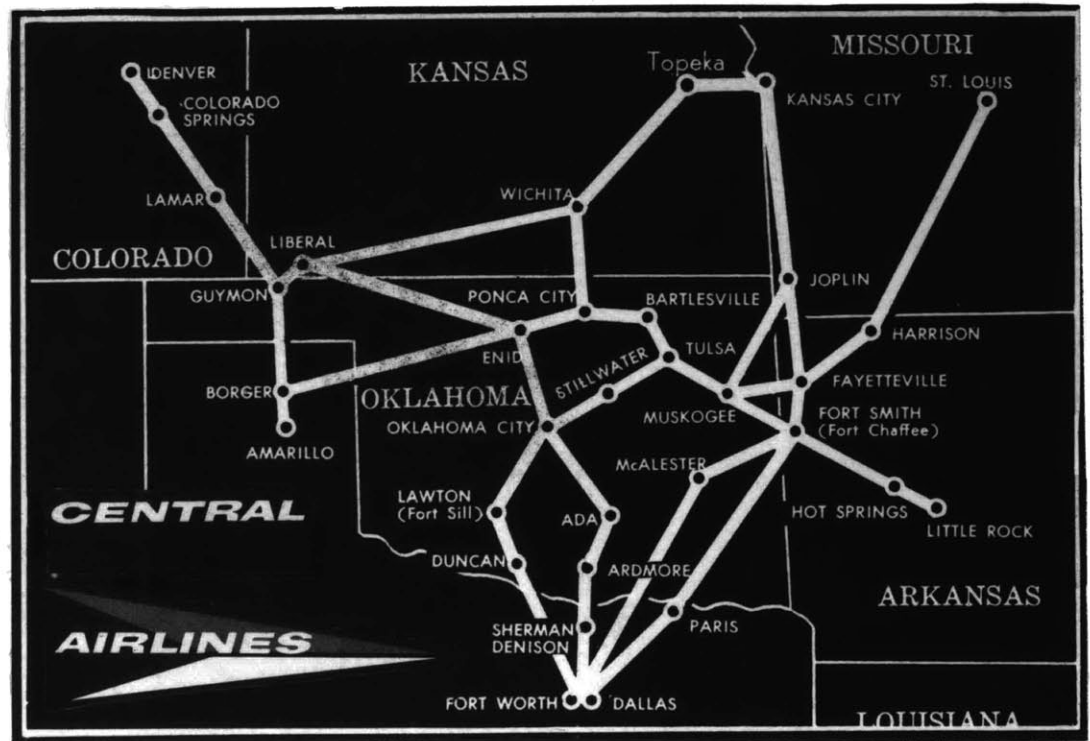
Central Mall

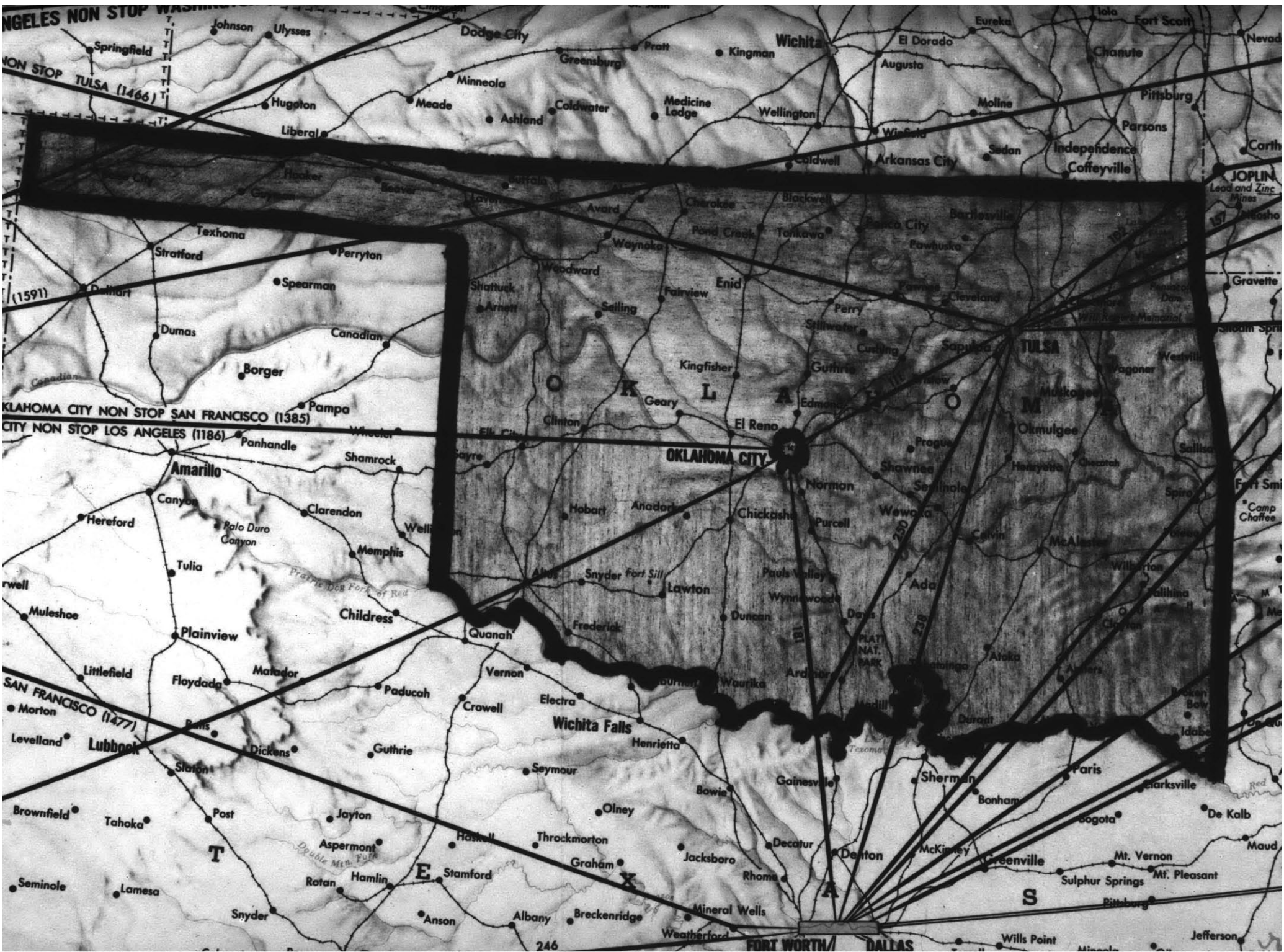
A mall, 60 feet in width, runs the length of the parking lots and focuses on the Monumental Fountain, the Control Tower, and the Passenger Terminal. This mall is curb height above the parking lots. The landscaping is varied, with special attention given to the shuttle bus stops. The Central Mall offers protection from automobile traffic for any pedestrian willing to make the hike from the parking lot to the Passenger Terminal.



Travel Trends: Expenditures for airline travel are expected to increase faster than for any other travel means, including the auto.

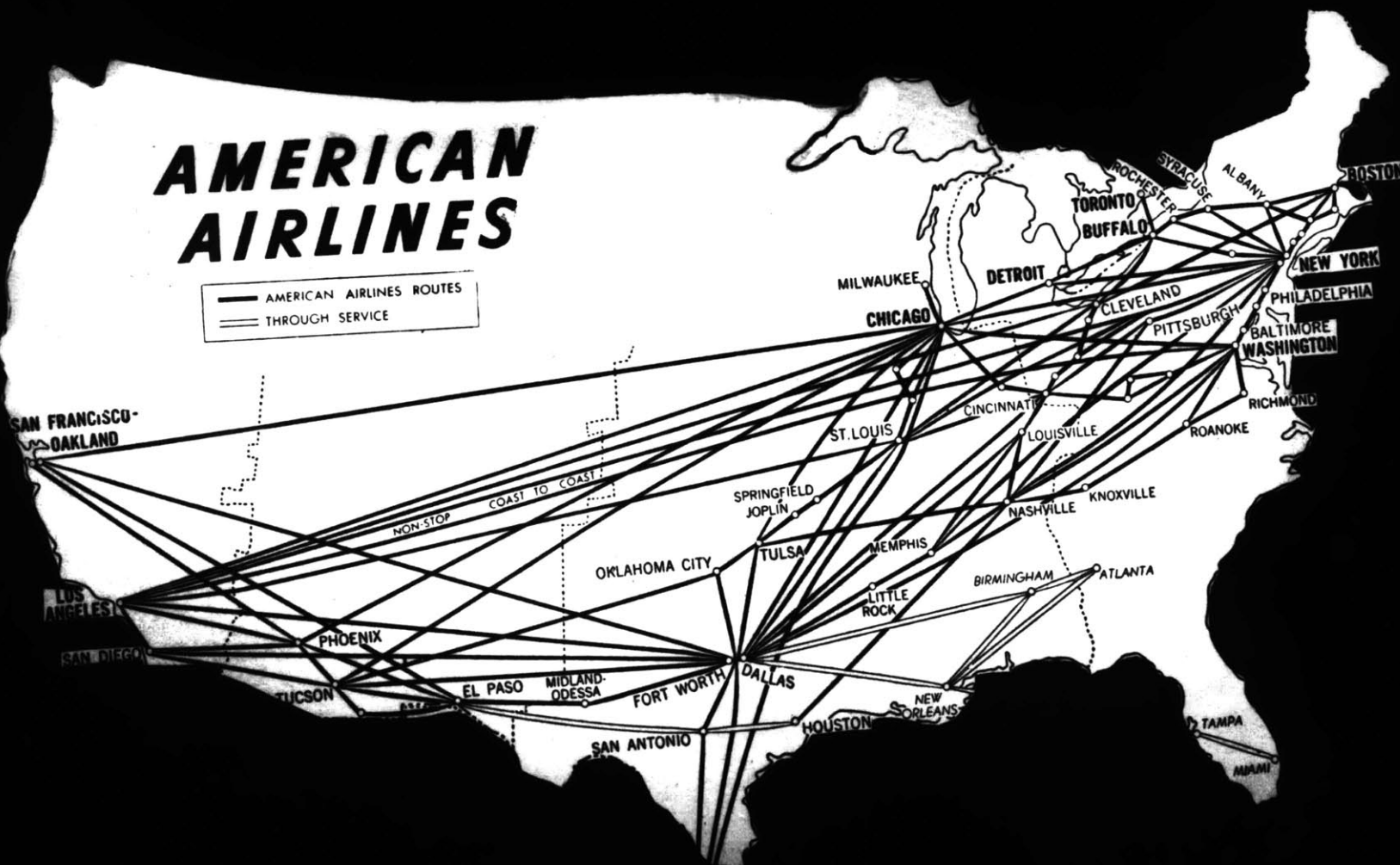
AIRLINE MAPS

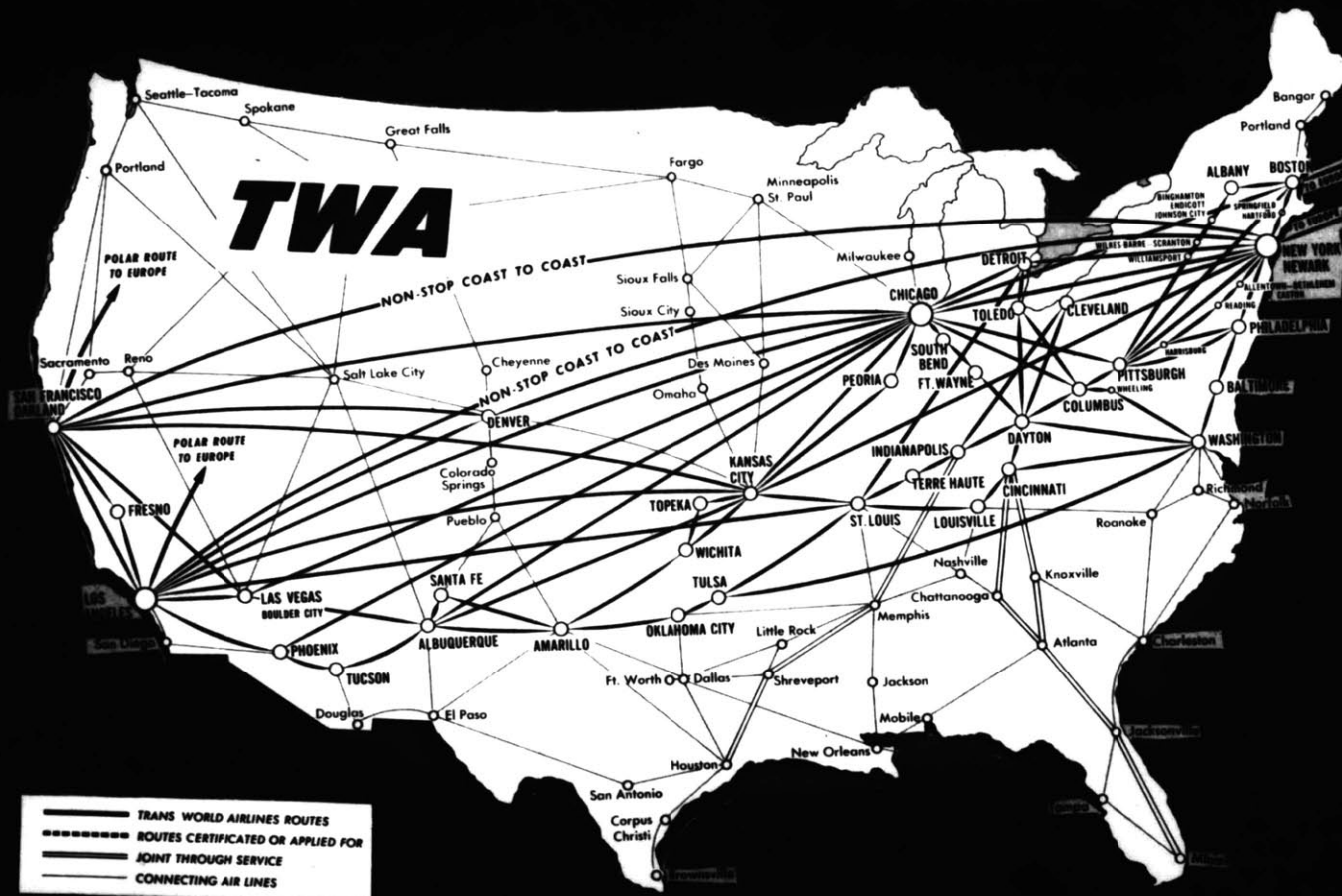


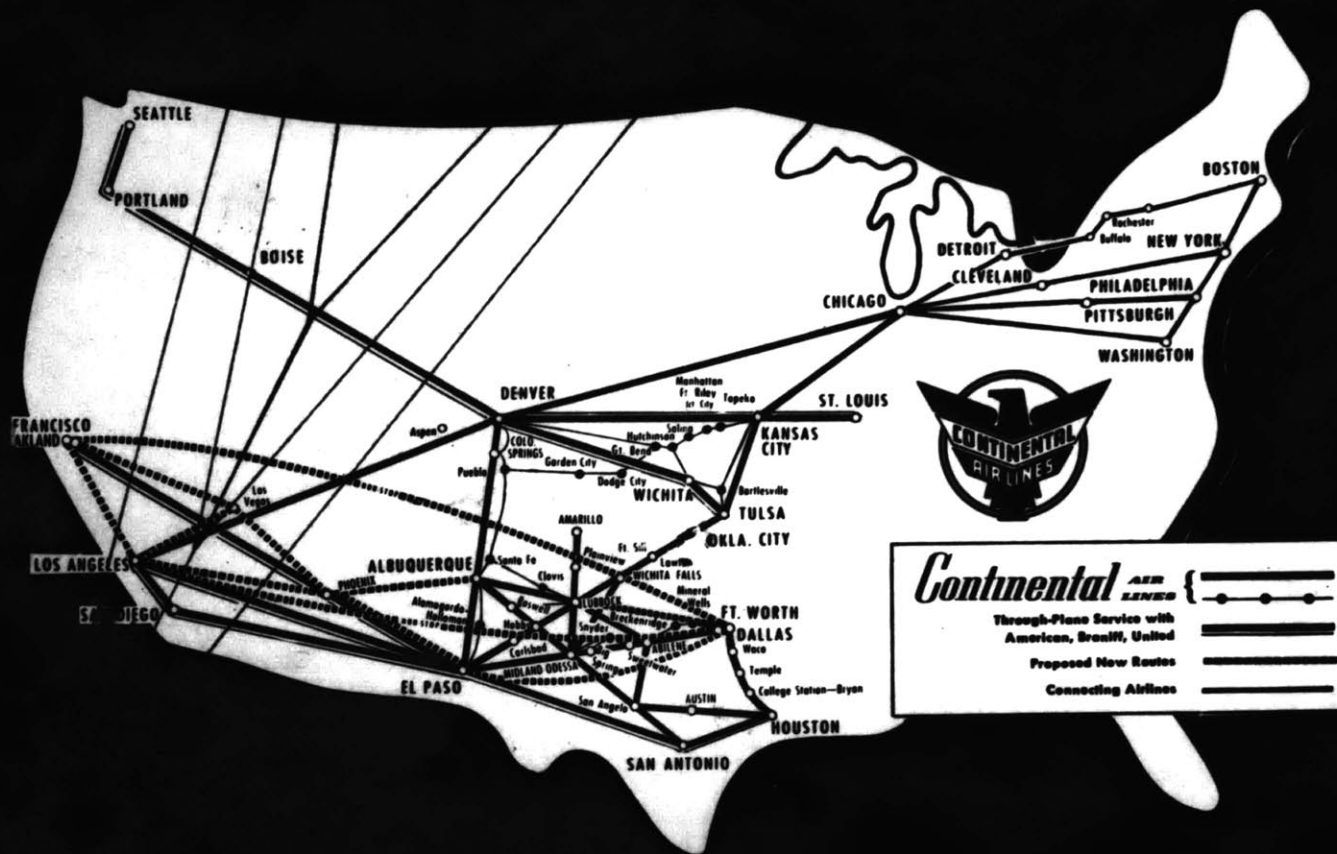


AMERICAN AIRLINES

— AMERICAN AIRLINES ROUTES
— THROUGH SERVICE





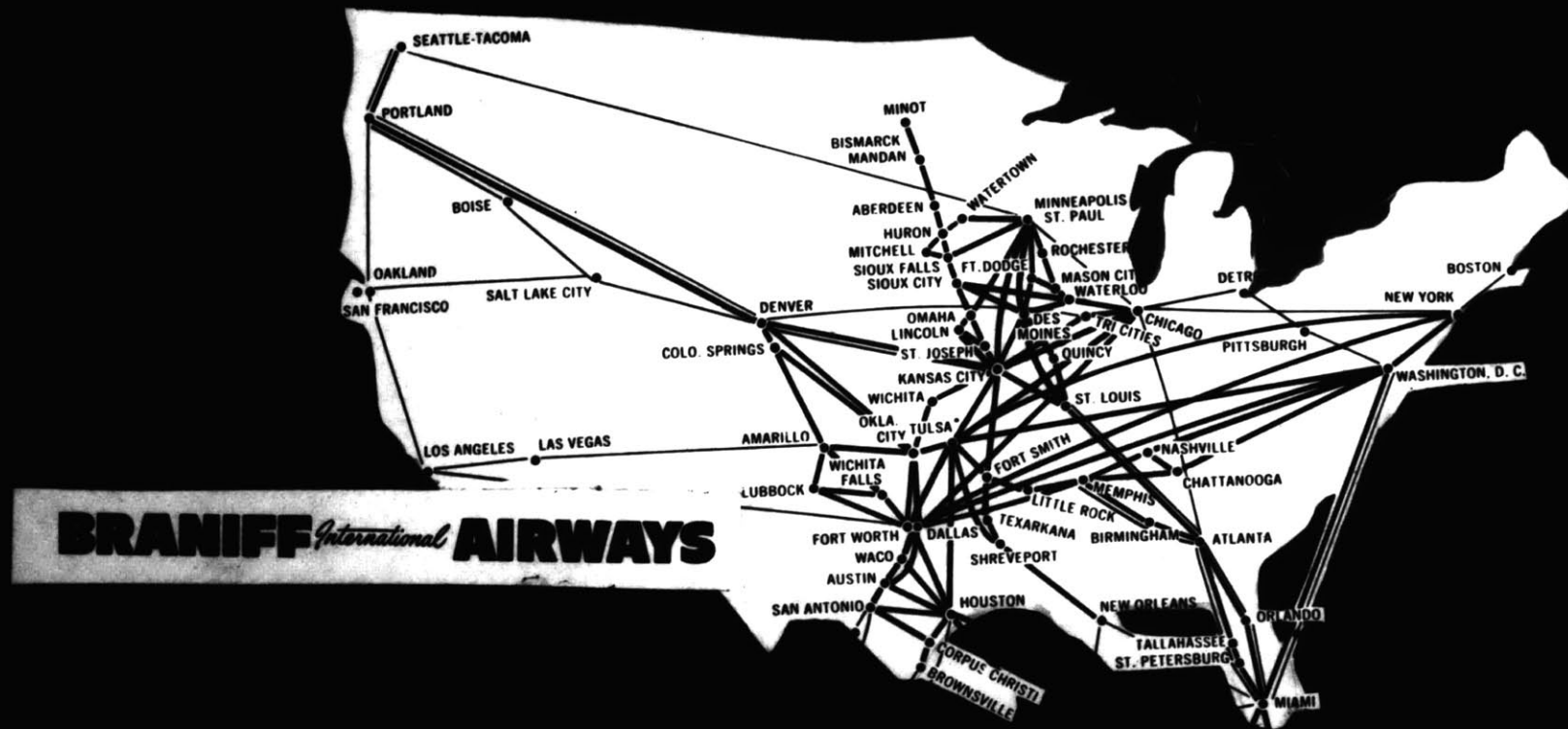


Continental AIR LINES

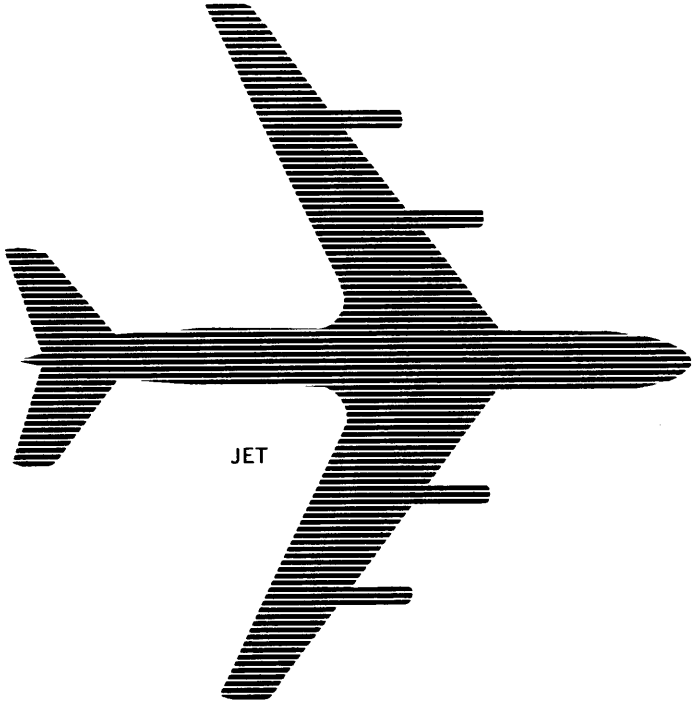
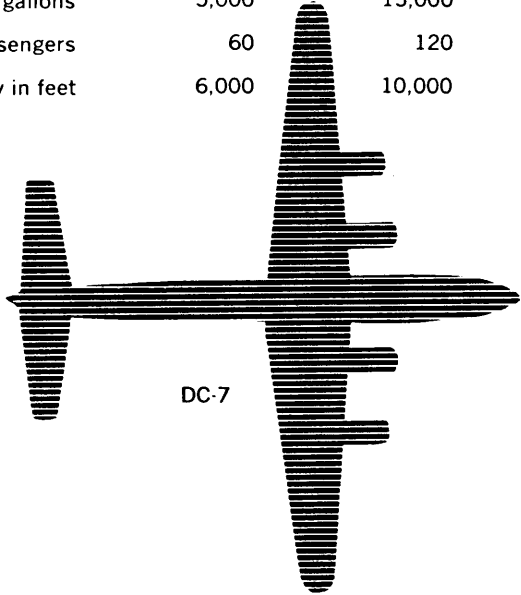
Through-Plane Service with
American, Braniff, United

Proposed New Routes

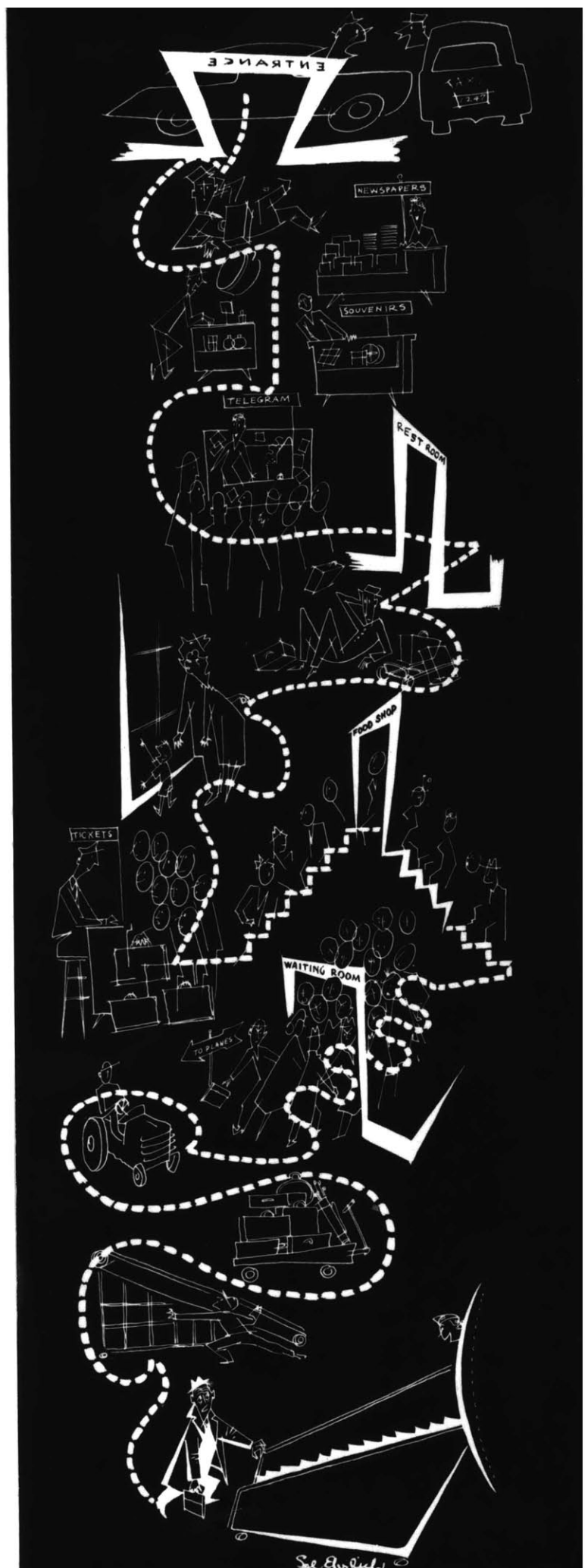
Connecting Airlines



	DC-7	JET
Weight in pounds	116,000	250,000
Cruising speed in miles per hour	360	600
Average fuel load in gallons	5,000	15,000
First-class passengers	60	120
Runway in feet	6,000	10,000



CIRCULATION



The Passenger Terminal is the dominant feature of the Master Plan. It consists of a three level Central Building, three two level Satellites connected to the Central Building by enclosed bridges, and a 140 foot Control Tower.

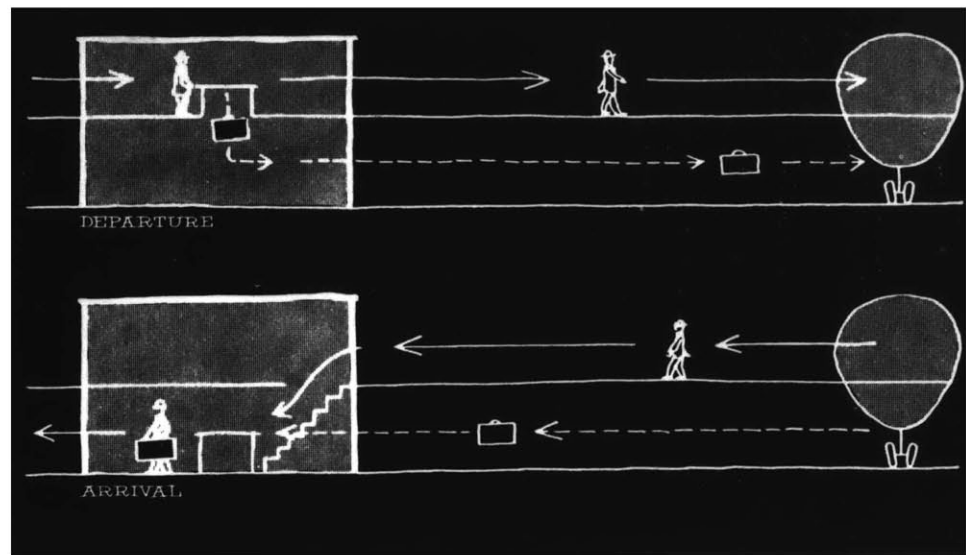
F. B. Butler of San Francisco, in a speech before the Airport Operators Council, listed two of the more important considerations involved in designing a terminal building. One is efficiency in handling both passengers and passenger baggage, and carriers' operations. The other involves provision for the comfort, relaxation, and enjoyment of the air traveller.

Centralized Plan

There are two general types of passenger terminal plans. The difference is in the placement of the airline ticketing in relation to the loading gates. The unit or decentralized plan allows each airline to handle its passengers from ticketing to loading without coming in contact with other airlines. Each airline's area is treated as a separate terminal with only specialized concessions developed in common.⁷ The plan works best at "end of the line" airports such as New York's Idlewild Airport and Boston's Logan Field.⁸ Where there are many connecting flights, it is best to use the second plan. This centralized plan has one ticket lobby, and frequently uses the same areas for handling baggage. Because of Oklahoma City's central location, many passengers make connecting flights. The centralized plan was chosen, therefore, to eliminate the duplication of many facilities, reduce walking distances, and supply direct contact to common areas such as the restaurant.

⁷"Airports," Architectural Record, April, 1945, p. 80.

⁸Walther Prokosch, "Airport Design: Its Architectural Aspects," Architectural Record, January, 1951, p. 118.



Traffic Separation

Another objective is the separation of airline functions from public and passenger traffic.⁹ Eliminating the snarl of people and baggage is particularly difficult at Oklahoma City, for in addition to passenger baggage, a great deal of Air Cargo and Air Express is loaded on the planes. The solution lies in a modified three level plan. Departing passengers enter their planes from the second level. Arriving passengers deplane there and go by escalator to the ground floor where they claim baggage and leave.¹⁰ All baggage, Air Cargo, and Air Express is routed through the basement.

⁹C. H. Taylor, "Passenger Handling In Terminal Area," Capital Airlines, Inc., April, 1956.

¹⁰"Airports For Tomorrow," Architectural Forum, January, 1958, p. 127.

CENTRAL BUILDING

The main floor of the Central Building is its second level, composed of five modular units formed of concrete hyperbolic paraboloids. The north facade wraps around three sides of an unloading area used exclusively for departing passengers. Wide vehicle ramps furnish access to this level. The fourth side of the court is flanked by the Control Tower.

The Pedestrian

Pedestrian access is provided from the parking lot to a court in front of the Central Building. The court is landscaped, and all but the roads and walks are planted with grass. Once in the court, the pedestrian is lifted above the unloading activity by an arched bridge which descends directly into the central unit.

Unloading

The use of shuttle buses eliminates parking congestion. Taxis and limousines have additional space, therefore, for their use in passenger and baggage unloading operations, which take place at the canopy bordering the building. The canopy also acts as a reference plane to the high ceiling of the "Big Room." Directional signs are strategically placed to facilitate in the location of the proper entrances. The sidewalk is the same texture as the main floor, but flower beds piercing the pattern add variety. Unattended vehicles are not allowed to remain at the entrances, so private autos either leave immediately or return to the parking lot. Taxis, limousines, and shuttle buses may circle the site or descend a special ramp to the arrival areas.

The Big Room

The visitor and the passenger enter the "Big Room" on the axis of the roof, which at this point is 48 feet high. The main paths of circulation are marked by high rib lines in the roof.

Ticket Desks

The ticket desks are located near the entrances and are on the court side of the "Big Room." The free standing desks are low enough that they do not block the view of the field.¹¹ One side of the desk is for purchasing tickets and the other is for checking baggage, which moves along a conveyer belt system until it descends by chute into the basement. Each airline has a two sided announcement board which is part of a low desk type unit enclosing the conveyer belt. It is possible for airline employees to take a circular stair from the desk to their offices below. This aids in the process of checking out receipts. The location of the counter gives direction to the main line of traffic, but allows for waiting space without blocking its flow. After checking in, the passenger is directed to his correct departure gate in one of the Satellites.

Information Center

The information center is centrally situated where all site lines in the terminal converge. The electric bulletin board and hexagonal counter conveniently provide fast and efficient direction to passengers and visitors. This board has three sides, each of which designates the name of the airline and the gate number.

Restaurant

The Sky Chief Restaurant of Will Rogers Field is regularly patronized at the present time by many non-flying customers as well as by airline passengers. In terms of passenger and visitor attraction, therefore, this section merits the largest floor space. The restaurant provides table service, a coffee shop, cocktail lounge, and a VIP room. These are separated by sculptural screens. The serving kitchen and check room are the only areas with partition walls. The cocktail lounge serves both its own area and the main dining room, thus eliminating the need for a second bar. It is also possible to open the dining room later in the evening for nightclub service.¹² The customers of any dining area will enjoy an exceptionally scenic view, but that from the main dining room is spectacular.

¹¹Buford L. Pickens, "Proud Architecture and the Spirit of St. Louis," Architectural Record, April, 1956.

¹²Charles A. Rheinstrom, Passenger Terminal Development Of The Cleveland Municipal Airport, July, 1948.

Lobby Concessions

The revenue earned by the lobby concessions places the Passenger Terminal on a paying basis. Their positions in the building should be carefully chosen to maximize sales activity. On the other hand, they should not interfere with the flow of passenger traffic. Well planned railroad terminals have shown from experience that concessions are not more heavily patronized when they block main paths of travel.¹³ One large grouping of low free standing desks provides sales and display space for a news stand, book store, gift shop, drug store, and florist shop. Telephones, civic and industrial exhibits form other areas. Informal lounges for observation and visiting are on the field side of the concessions. There are two other similar lounge areas.

Lighting

During the day, sunlight floods through the glass walls. Gray heat absorbent glass and green or clear glass is patterned to produce an interesting lighting effect, while at the same time reducing the air conditioning problem caused by glass heat. The artificial lighting of the desks and roof is carried in large chandeliers, suspended from the center of each modular unit low enough to establish a central plane of reference. This lighting is similar to that used in Byzantine churches. Additional lights can be installed in the concession and ticket counters.

Vertical Circulation

All sections of the "core" are connected to the floors below by elevators, escalators, or dumb waiters. The main flow of traffic uses three sets of escalators banked under the high area formed by the intersection of the roof ribs.

The arriving passenger disembarks from his flight into the second floor of a Satellite Building. From here he proceeds into the Central Building and takes the escalator to the ground floor. All three escalators are oriented to direct descending traffic to the baggage claim area.

¹³Prokosch, op. cit., p. 117.

Baggage Claim Area

This area has three entrances and one central exit. The exit consists of two gates, between which one or two employees can check outgoing baggage. The baggage travels from the basement on a high speed conveyer system. It is then mechanically taken from the container and chuted to an adjacent pick up counter. The aim of the airlines is to have the baggage unloaded from the plane and ready for passengers by the time they reach the claim area.¹⁴ The passenger picks up his own baggage and moves to the check out point defined by lines of baggage lockers and telephone booths.

Loading

Western Union, Rent-A-Car agencies, taxi, limousine, and helicopter taxi services have two-sided counters opening into the baggage claim area and the central hall. This allows the passenger to make arrangements for his transportation at the same time that he claims his luggage. The passenger may then proceed to a shuttle bus, taxi, or private automobile. The road for arriving passengers is on the field side of the plane. An adjacent area is for Rent-A-Car parking and automobile, taxi, and limousine waiting. A louvered wall, a landscaped strip, and wind screens separate the road from the field. The landscaped strip not only makes the loading area more attractive, but also cuts down on the glare reflected to the second floor glass walls. Wind screens prevent top soil from blowing into the roadway.

Rest Rooms

The large rest rooms are grouped at this level in a unit composed of a man's clothing store, a barber shop, a women's clothing store, and a beauty shop. Dressing rooms, showers, and valet service are available here also.¹⁵

¹⁴"Airports For Tomorrow," p. 127.

¹⁵F. B. Butler, "Terminal Building Design and Construction Notes," speech presented at Airport Operators Council, Ninth Annual Conference, Philadelphia, Pennsylvania, April, 1956.

Game Room

A game room, an excellent source of revenue, is located on the central hall. This area has demonstrated its popularity for relieving the boredom of waiting passengers. Travellers may enjoy the recreation facilities available here--television, pinball machines, ping pong, etc.

Hotel

Other concessions include additional telephones, lockers, a gift shop, news stand, and a forty-two room hotel. The hotel has a separate loading area in front of the desk. The large lounge adjacent to the entrance area can be portioned to allow for business conferences and receptions.¹⁶ Room service is available from a centrally located coffee shop and bar. The rooms are of two types--the traditional hotel design and the "roomette," a compartment slightly larger than a Pullman.¹⁷ All rooms are arranged on four interior courts to avoid airport noise. The exterior wall has strips of glass placed high to give the corridor light. The long section acts as a retaining wall for an embankment. It is principally arriving passengers who will use these facilities, but some rooms will be reserved for those affected by grounded flights. This hotel is not intended for general accommodation in competition with the major hotels of Oklahoma City.

Kitchen

The kitchen of the restaurant includes space for service docks, storage, preparation, offices, and employees' lounge. It is connected to the basement catering kitchen by two elevators.

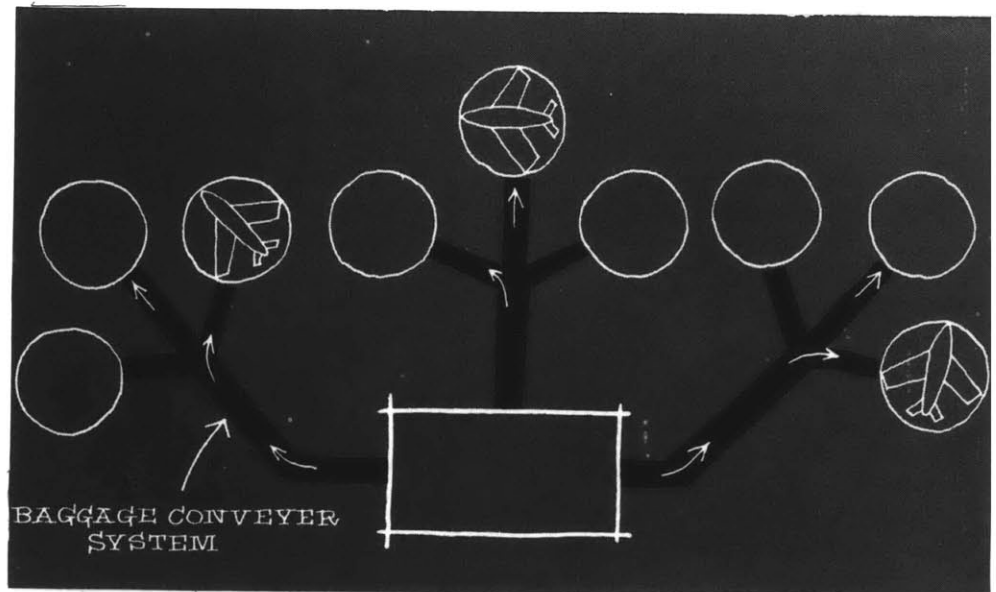
Offices

Three groupings of offices provide space for airline and airport administration, weather bureau and CAA safety facilities. The airport manager's suite includes a reception area, conference room, business and auditing provisions, and offices for the manager, assistant manager, and airport engineer.

¹⁶James H. Winchester, "Airport Hotels On The Way," Flight Magazine, August, 1954, p. 35.
¹⁷Butler, "Terminal Building Design and Construction Notes,"

Basement

The equipment for handling passenger baggage, Air Cargo, and Air Express is centralized in the basement. Departing baggage is chuted to the area from the ticket counter, where it is loaded into container "units" specially designed for the plane's cargo compartment.¹⁸ Arriving baggage is conveyed down a ramp from the Satellites. Air Cargo and Air Express have loading and unloading docks at this level. Here, also, are locker rooms and cafeteria for airport employees.



Central Switch

Each Satellite has two conveyers--one moving in each direction. These conveyers are fed into a central loop by electronically operated switches. A cut off from the central switch takes passenger baggage up to the ground floor and then returns with the empty containers. Other conveyers feed the storage area and catering kitchen, which prepares food for airline flights. A service tunnel and employee passage carries the conveyor belts, pipes, wiring, and ramps up from the basement to the ground floor of the Satellite.

¹⁸American Airlines, Inc., "Turbine Planning," an active file on jet age aviation and the handling of jet and turbo-prop aircraft, 1957-1958.

SATELLITES

Bridges

The Satellites are large rooms similar in design to the modular units of the Central Building. Each is connected to the Central Building by an enclosed bridge. It might be possible to install moving sidewalks in the bridge, but at the moment their operation is so slow that it would take four minutes to reach the Satellite from the Central Building. Rest rooms, a nursery, telephones, and observation are on the second floor of each bridge. The nursery is a great convenience, particularly to passengers who have a waiting period between flights.

Helicopter Taxis

Escalators near the Central Building lead to a ground level departure room for helicopter taxis. A baggage switch routes passengers' baggage from an arriving airline. The helicopter taxi service, however, might function more smoothly if developed in a way similar to bus operation. "Passenger turnover will be fast and frequent...and ticketing and baggage handling...will be tailored for speed and ease of operation."¹⁹

Airline Operations

The remainder of the ground floor is reserved for airline administrative and service space. This area will aid in coordinating ticketing, loading, etc., and will considerably increase operating efficiency.²⁰ A transverse opening for field trucks connects the two sides of the plane area.

¹⁹ "Airports Facilities."

²⁰ Butler, "Terminal Building Design and Construction Notes."

Satellites

The Satellite performs the double function of serving as a reception room for arriving passengers and a waiting room for departing passengers. The main problem is "how to process a large number of passengers for boarding without causing congestions or without delaying the departure of the airplane."²¹ Since many passengers not only arrive at the airport early, but check in well in advance of departure, a holding area has been developed at the gate. This enables the airline to spread the workload and reduce terminal congestion.²²

Departure Rooms

Each Satellite has six loading gates--four of them are large enough to handle large long range jets. The other positions will be used exclusively for intermediate jets and turbo-jet aircraft. Although planes of different sizes use the same gates, the American Airlines' research program has shown that all holding areas, or departure rooms as they are called, should be of uniform size. This study further states that their areas should handle 122 passengers, seating for half and milling room for the balance. Since even these areas will be over crowded during operational delays, this plan provides more space than the American Airlines requirement. This allowance will also permit the introduction of planes with a larger seating capacity. An additional load will be placed on the Satellites, for it would probably be impractical to prevent visitors, friends, and families from entering the area. There is a growing trend toward the synchronization of the times of flight departures, but the room would be left open for visitors and guests during the relatively quiet periods. Each airline will furnish its own area and develop individualized passenger facilities. Marvin Whitlock, head of jet planning for American Airlines, stresses this type of terminal design. Recently, he stated, "We've pretty well exhausted the opportunities for competitive advantage in in-flight service. We can all buy the same equipment. The only chance for competitive advantage will be on the ground."²³

²¹American Airlines, Inc. op. cit.

²²Ibid.

²³Marvin Whitlock, quoted in "Airports For Tomorrow," p. 124.

Gates

Since the trend in aircraft design is toward emplaning and deplaning at two points, each Departure Room has two gates. These can be located in the glass wall according to the choice of the airline, but it is recommended by this thesis that they be placed at the corners. This arrangement has several advantages. First, it clearly defines the loading areas for pilots; second, it allows for simultaneous loading and unloading of passengers without having cross circulation; third, it offers covered entrance to the plane; and fourth, it acts as a blast fence system, protecting one area from the other. It is also possible to give first class passengers special treatment prior to entering the plane. A telescoping flexible connection joins the gate to the airline door.

The Airplanes

It is difficult to predict the design of future aircraft, but development will probably take place along the lines of the new jets. One other type of aircraft may come into common use. It is quite possible that helicopters will replace the present carriers of short-haul traffic. Their design can only be a matter of speculation, but the helicopters will probably be larger than those we know today.²⁴ Unlike the helicopter taxis, they will be able to load passengers from the second floor and will, therefore, use the Satellite.

Airplane Servicing

The ground floor of the Satellite is exclusively for servicing airplanes and handling baggage. A good part of the equipment used in servicing planes will be housed in the newer models; however, equipment for plane air conditioning, compressors, generators, and starting can be centralized in this one place. Some electric power connections are required for these services. Fueling is pumped into the plane from connections buried in the pavement. All gas and oil trucks are thereby eliminated, but a sub-pumping station may be necessary in this central location. Handling other services in this manner removes the need for vehicles being on the field.

²⁴"Airports Design," Aviation Age, July, 1954, p. 194.

Baggage Loading

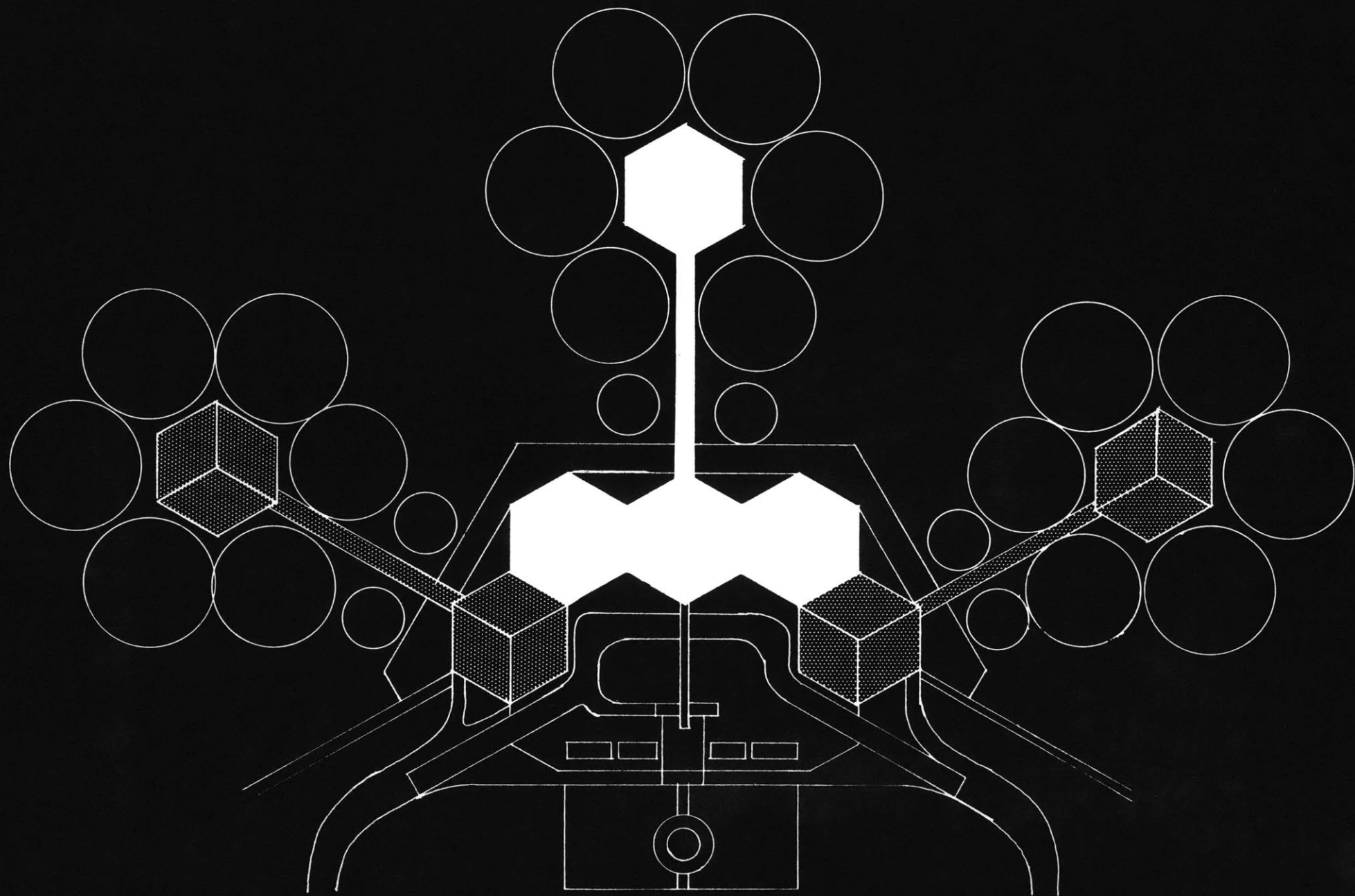
All baggage container units, once loaded, are conveyed to the ground floor of the Satellite for holding. They can either be switched into the blast fences or held in a central area. Few employees are allowed on the field during the arrival of a plane, so they will wait within the blast fences. Once the plane has stopped and the flexible connection is in position, baggage loading and unloading can take place. The airlines will either handle the baggage containers with mechanical hoists, or conveyer belts.²⁵ Special attention can be given to interchanging luggage either at this point or from the central baggage switch. Each airline will employ its own personnel to handle luggage.

CONTROL TOWER

The remaining element of the Passenger Terminal is the Control Tower. All essential functions within the Tower can be performed by telephone connection with the Central Building, so this structure may be somewhat removed with no sacrifice of efficiency. The main requirement of the Tower is visibility. This means that the Tower must have control, not only of passenger aircraft, but of all planes moving on the field. The building has seven floors, serviced by an elevator and stairs. There is sufficient room for the cab, shops, storage, and offices for weather observation, reception, and the chief of controls. A cantilevered observation deck projects from the center of the Tower.

²⁵American Airlines, Inc., op. cit.

EXPANSION AND FLEXIBILITY



THE CORE

"The Terminal Building as basically planned should be viewed as the central hub of an expanding facility."²⁶ All of the basic elements of the core should be capable of expansion without radical changes being necessary. In this thesis the core consists of four hexagonally shaped modular units. In plan, each side of the hexagon is 96 feet. Three units comprise the Central Building; the other, a Satellite. Ticket space, information desk, lounges, concessions, and facilities for eight gate positions are in this core. The restaurant has a sub-core--the serving kitchen, from which internal enlargement is possible according to need. Since this section is the first to be built, the helicopter taxi gates can be used for propeller-driven aircraft. The ground floor, which is also begun at this time, should be constructed with a full basement. The first building stage will come before 1970 followed by the other units and their Satellites, built simultaneously or one at a time. This thesis presents the completed scheme, based on figures from the Master Plan which lists the maximum number of gate positions as twenty-four.

²⁶Butler, "Terminal Building Design and Construction Notes,"

SPACE REQUIREMENTS

Core and Two Additions1980

Area Requirements (Estimations)	Tickets	650 L.F.
	Counter	9,000 S.F.
	Counter Work Area	
	Baggage	
	Counter Rail	244 L.F.
	Work Area and Lobby	28,000 S.F.
	Rest Rooms	
	Men	5,000 S.F.
	Women (and Nursery)	6,000 S.F.
	Restaurants	11,000 S.F.
	Kitchen	18,000 S.F.
	Hotel	8,600 S.F.
	Other Concessions	7,000 S.F.
	Passenger - Visitor Lounges (including Departure Rooms)	27,000 S.F.
	Control Tower	5,200 S.F.
	Airline Operations	80,000 S.F.
Passenger Data	Annually Emplaned	960,000
	Annually Planed and Deplaned	2,000,000
	Peak Hour	800
	Lounge Seating Capacity	1,600
	Number Hotel Units	42
	Number Gate Positions	20
Airplane Parking	Required Turning Radius At Gate Positions	
	Transcontinental Jets	109 Ft.
	Intermediate Jets	90 Ft.
	Turbo Jet and Propeller Craft	160 Ft.

DESIGN TECHNIQUES

Since each modular unit rests on only three points, no additional columns pass through the floor below. Because the Satellite uses the same modular unit as the Central Building, there is no duplication of construction forms. By grouping the facilities and making their exterior walls load bearing, it is possible to achieve the advantage of an unbroken floor on every level. In addition, the use of a tetrahedron floor system allows the placement and removal of partition walls. Since the modular units are handicapped by few columns, a free hand can be given to decoration and spacial arrangement. Of course, all furniture should be kept low to prevent blocking the view of the field. Certain architectural treatments are recommended to aid in making the second level adaptable to changing needs. The spacial requirements of ticket desks, concessions, and restaurant vary. Free standing counters, composed of interchangeable modular units, allows adjustment in the ticket desks and concessions. Since the restaurant is basically an open plan, movable sculptural screens serve as space dividers and may be placed for maximum utility. This construction system provides elasticity of design, even to the addition of a new airline, and aids in producing organized variety in the concession arrangement. Most lighting and all air conditioning is carried in the floors.

Ventilation

Each of the three columns supporting a modular unit contains a venting pipe which brings fresh air into the structure. The interior kitchens and rest rooms have access to one of these vents. The roof form protects the vents from disagreeable kerosene odors, which require more careful treatment than gasoline fumes.²⁷

²⁷Marvin Whitlock, "Turbine Airplanes As Seen By Present Airports," presented at Airport Operators Council, Tenth Annual Meeting and Conference, Chicago, Illinois, May, 1957, p. 6.

Loading Procedures

The use of interior columns frees the outside wall for any loading procedure the airline chooses. At the moment, the airlines have not decided the best method for bringing the jet aircraft to the gate and self-powered taxiing still seems quickest. One alternative is to halt the plane at some distance from the Terminal and manouver it to the gate by some other means. The hexagonal Satellites are adaptable to either system.

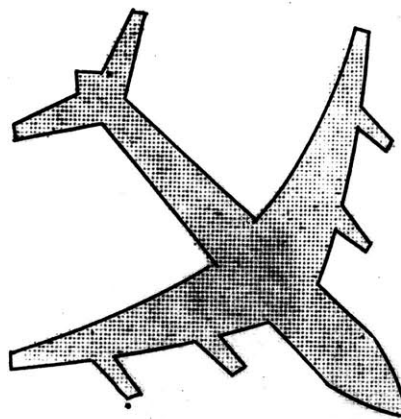
Parking Patterns

The parking patterns (see illustration next page) used at the gate, will determine what alteration must be made to Satellite facades. Angle parking is the conventional position, but this requires passenger loading from the ground and exposes passengers to the elements. A second position places the plane parallel to the Terminal, and boarding procedes from the second floor. To reach a third position, the plane must "nose in,"²⁸ The two latter systems work well with the hexagonal Satellites, but the parallel plan offers the most advantage.

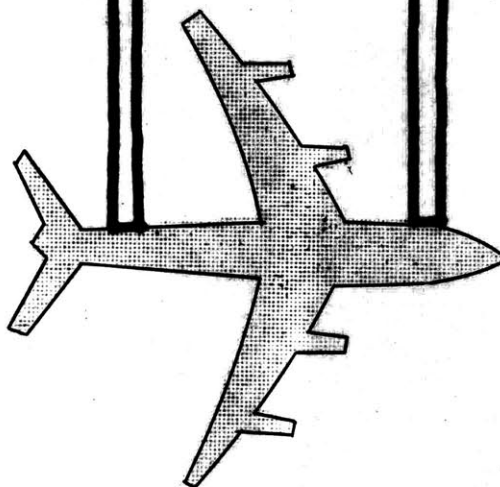
²⁸"Airports For Tomorrow," p. 125.

PARKING PATTERNS

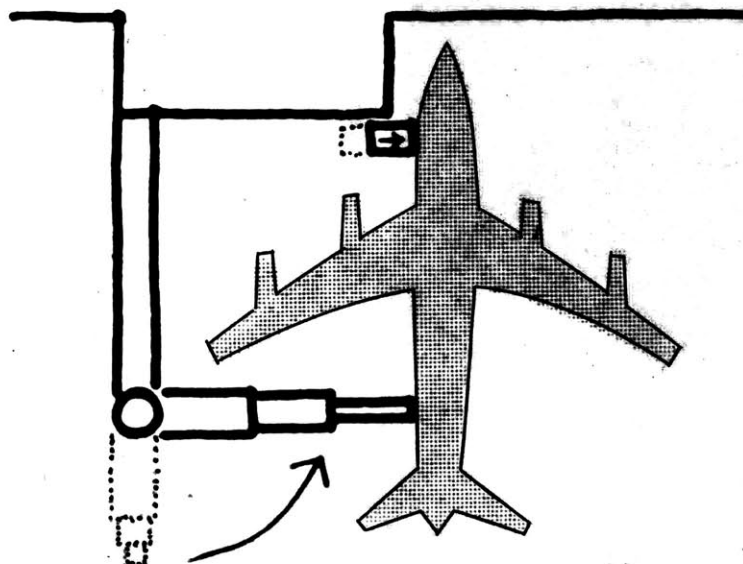
Angle



Parallel

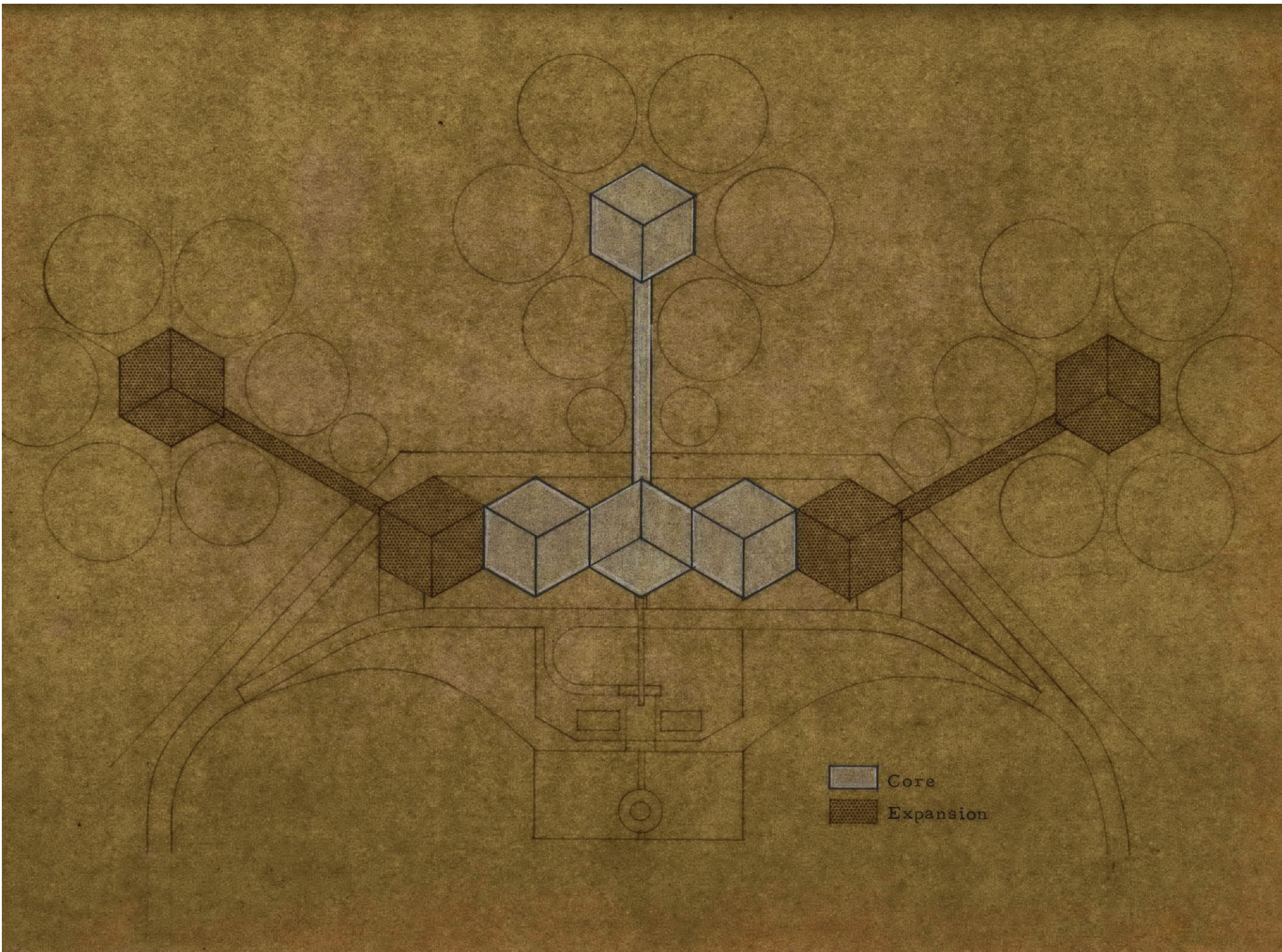


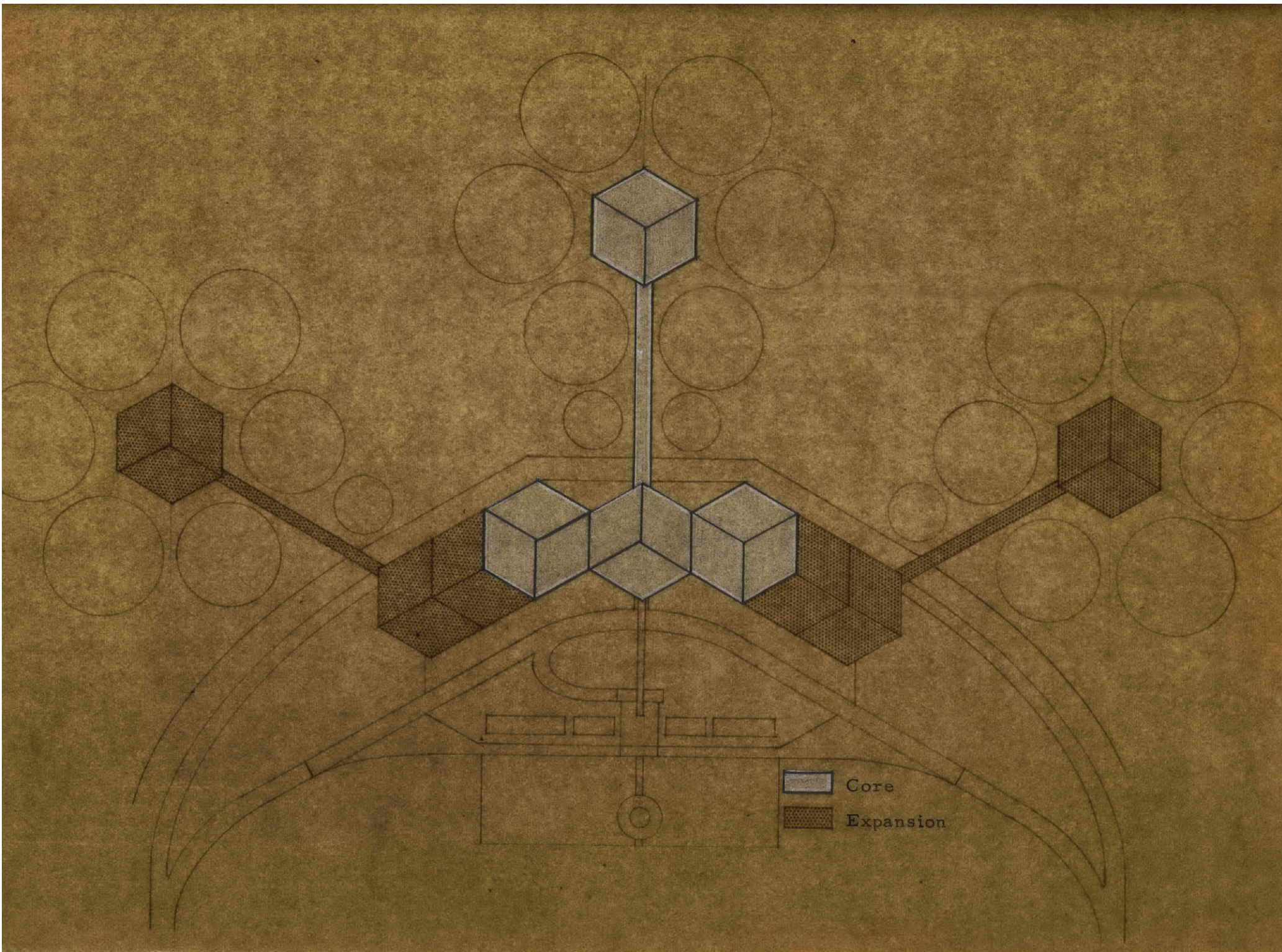
Nose-In



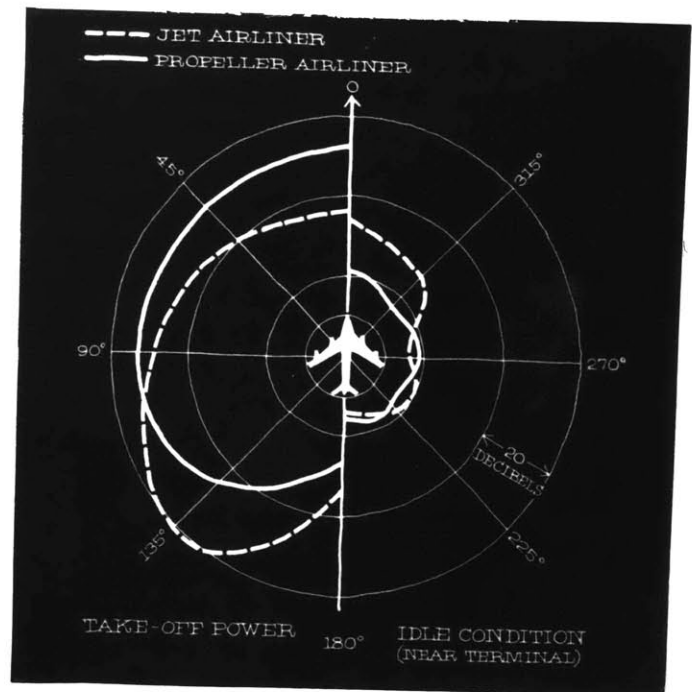
ALTERNATE SCHEMES

As an example of Terminal flexibility, it should be noted that it would be possible to enlarge the building if the number of gates should increase or if unforeseen circumstances require the addition of modular units to the core along the central east-west axis. This places the Terminal in one line and would provide for a modification of the passenger approach and gate position. The second method involves the addition of two sections of the modular unit to two ends of the core, producing a V-shape rather than the U-shape of the present plan. These additions could theoretically continue indefinitely, but probably would not create a pleasing architectural solution. Either scheme maintains the same Terminal pattern as that described in this thesis. (See illustrations.)



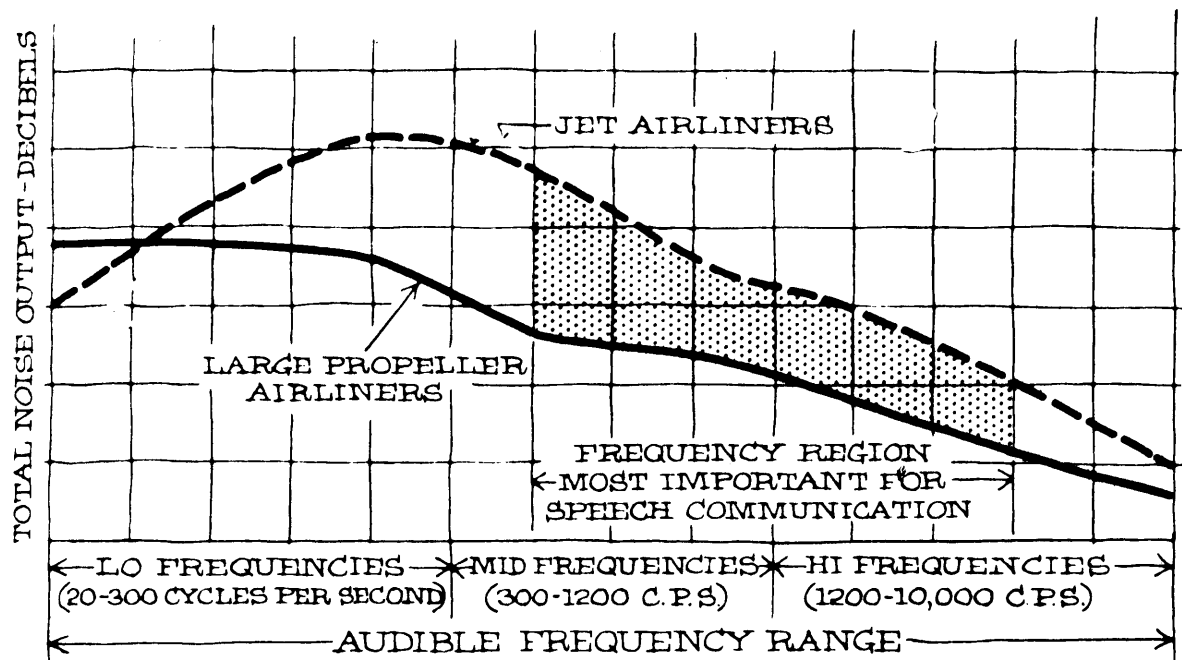


EXHAUST BLAST AND NOISE CONTROL



Noise Problems

Jets and turbo-prop aircraft create two new major problems in air terminal design. The first is "the ear splitting sounds of a turbine,"²⁹ The noise which originates at the compressor is very directional, of high intensity, and not easily absorbed. "The sound is not harmful during short periods or intermittent exposure, but is irritating and some would consider it painful,"³⁰ If the new airplanes taxi into the Terminal Building as in the past, measures must be taken to protect employees and passengers. The graph below shows a comparison of noise levels at take off between a jet airliner and a piston-engine plane. The shaded area shows the great reduction of audibility made by the jets.³¹ The graph on the preceding page illustrates the directional noise patterns made by jets. "The patterns in the graph are based on the frequency region most important to speech communication--between 300 and 5,000 cycles per second,"³² The significance of the graph is that it shows that idling noise is greatest in front of the plane, and take off noise is at its maximum at the rear. Either situation could considerably limit communication in the Terminal area.



²⁹"Airports Design," p. 88.

³⁰Whitlock, "Turbine Airplanes As Seen By Present Airports."

³¹"Airports For Tomorrow," p. 128.

³²Ibid., p. 128.

Control

Two methods have been used in this thesis to control noise. The first is based on the principle that distance from the source is the greatest aid in securing a quiet area. All jet and turbo-prop planes have been kept at least 200 feet from the Central Building. The hotel, which is the most critical area, is placed furthest from the gate positions. To insure proper sleeping conditions, all rooms have been kept interior. Additional study, however, may show that all glass areas will still need special treatment.

The second method of control is by the selection of materials which offer the most protection. On the ground floor, heavy masonry construction can be used, but due to the nature of the roof, glass walls are more appropriate. The noise in the departure rooms depends greatly upon the manner used by the airline to taxi in. If the parallel method recommended in an earlier section of the thesis is used, the noise directed toward the Terminal will be of short duration. This will not eliminate special treatment of the glass walls, but it may help in improving communication. All glass walls must be composed of at least two 1/4 inch panes, six inches apart. The chart below shows the relationship between noise reduction and material used at a distance of 100 feet from the source. It should be noted that the effectiveness of the walls depends largely upon the sealing of its openings.

Difference (in decibels) Between Inside and Outside Noise Levels

<u>Construction</u>	<u>Frequency: Cycles Per Second</u>		
	<u>Low</u> (20-300)	<u>Middle</u> (300-1200)	<u>High</u> (1200-10,000)
8" Concrete Masonry	35	50	60
Double Glass Two 1/4" Panes, 6" Apart	30	45	65
Doors and Windows Partly Sealed	27	30	30

Calculations* show that outside observation near the Central Building may be quite uncomfortable, but with the above precautions taken, normal conversation inside the building will not be affected. For reverberation control, it will probably be necessary to treat the concrete roof of the Central Building and the Satellites with a sound absorbent material, for instance, a sprayed fibrous material.

Exhaust Blast

The control of exhaust blast velocity is no particular problem in turbo-prop planes, but in the turbo jet, blast is considerably more directional. "It is directed more downward and has a strong sweeping action on surfaces, particularly in a turn."³³ Since all passengers are never outside when loading on planes, they are in no danger. The real problem is to protect airline employees in areas adjacent to arriving and departing jets. Blast fences separating gate positions are a necessity where airplanes are taxied to the gates in the conventional manner. Since the ground floor and blast fences in this thesis are of masonry construction, employees remaining in the structure are also protected at the gate. Most airlines have undertaken a safety training program and supply protective equipment for their employees. The solution may be in replacing employees needed at the gate with mechanical equipment.

*All calculations are based on data supplied by Bolt, Beranek and Newman, Acoustical Consultants.

³³Whitlock, "Turbine Airplanes As Seen By Present Airports," p. 7.

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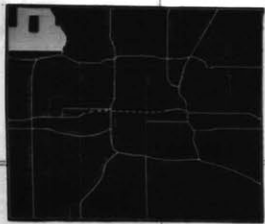
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AREA MAP

INDUSTRIAL SITES

C.A.A. EXPANSION

C.A.A. CENTER

GENERAL AVIATION

AERIAL PHOTOGRAPHS

1/2 MILES TO DOWNTOWN OKLAHOMA CITY

NATIONAL GUARD

INDUSTRIAL SITES

SITE PLAN - Scale 1" = 600'

NORTH

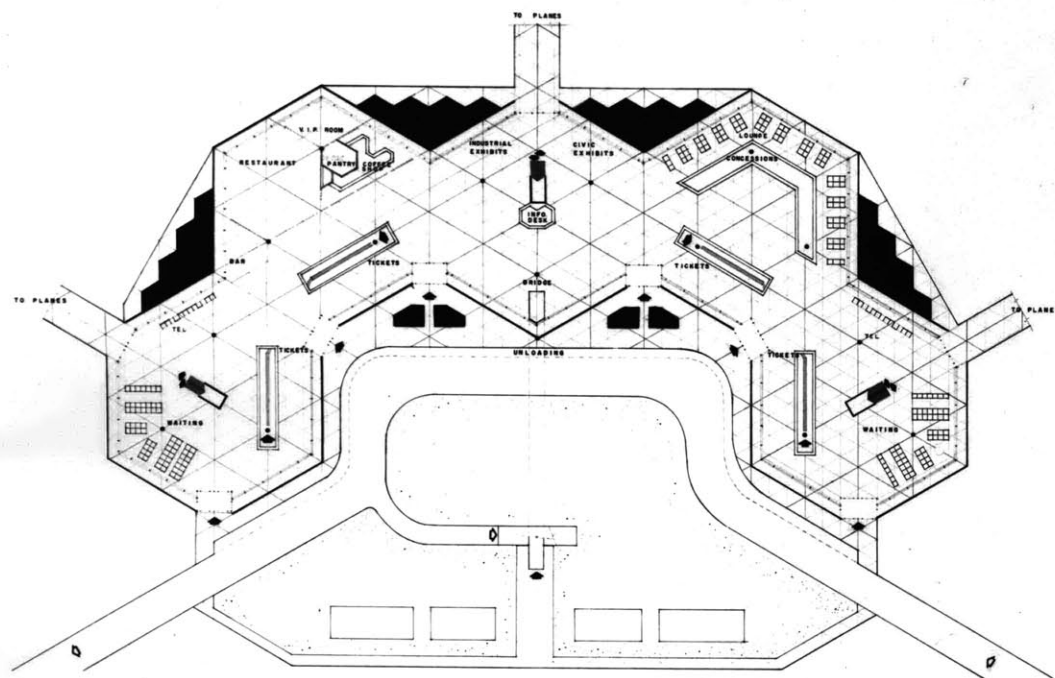


AN AIR TERMINAL FOR OKLAHOMA CITY MUNICIPAL AIRPORT

REX M. BALL

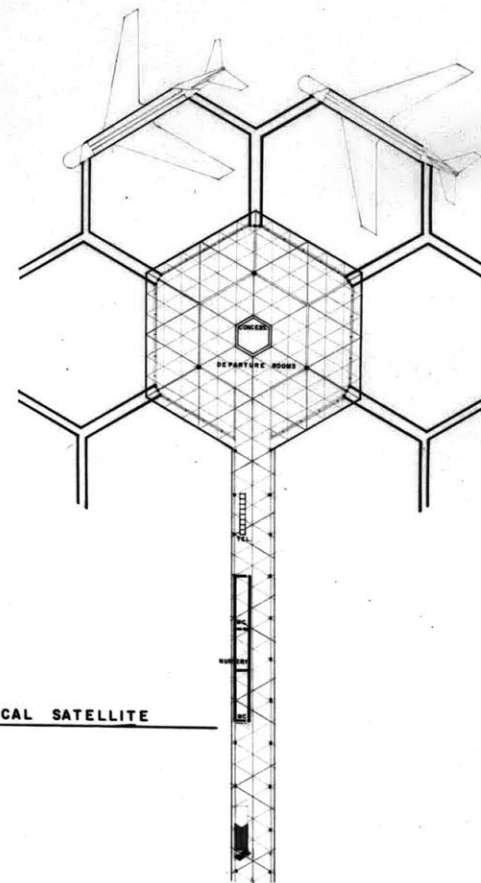
EXPANSION DIAGRAM



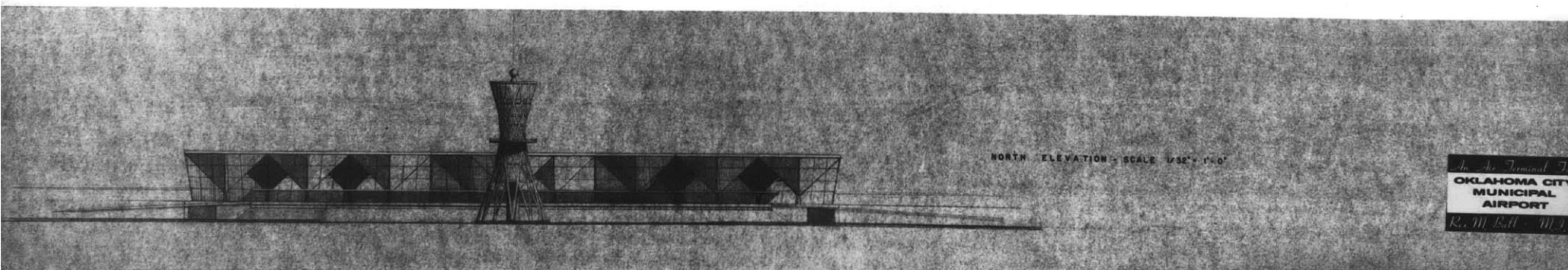


DEPARTURE LEVEL

SECOND FLOOR

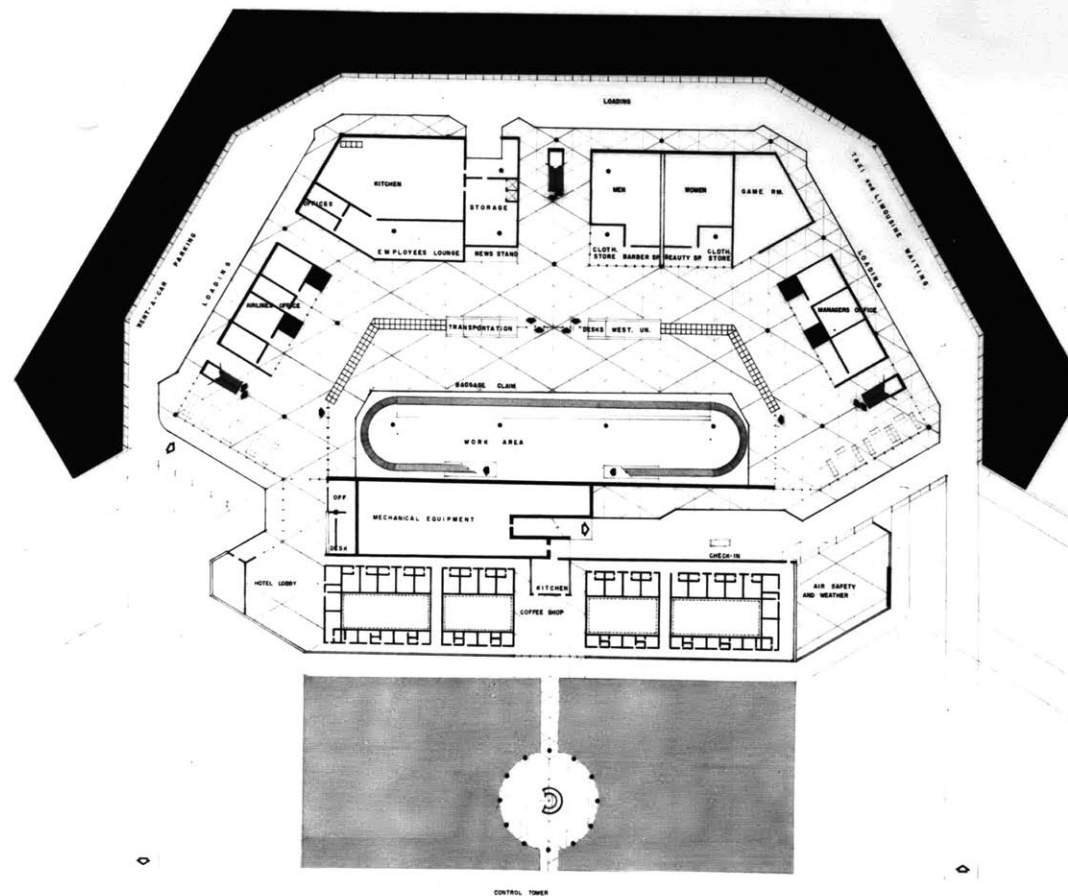


TYPICAL SATELLITE



NORTH ELEVATION - SCALE 1/32" = 1'-0"

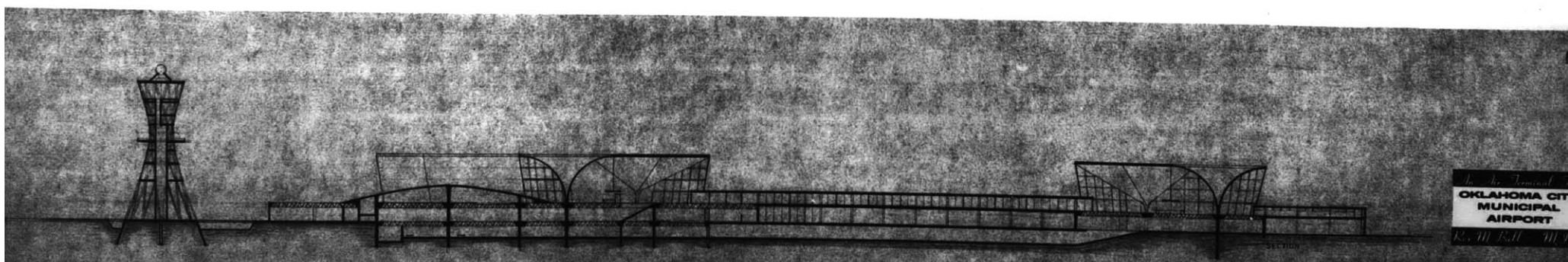
In the Terminal
OKLAHOMA CITY
MUNICIPAL
AIRPORT
R. M. Ball - M. J.

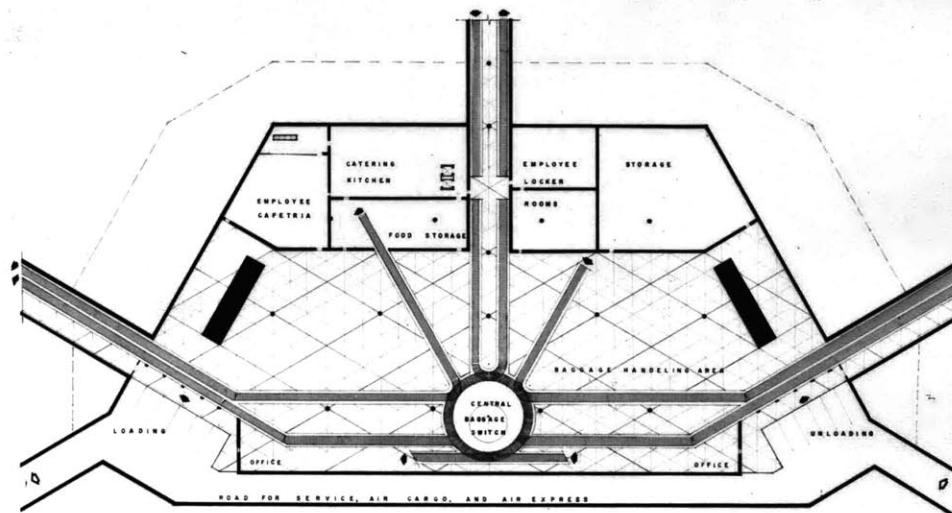
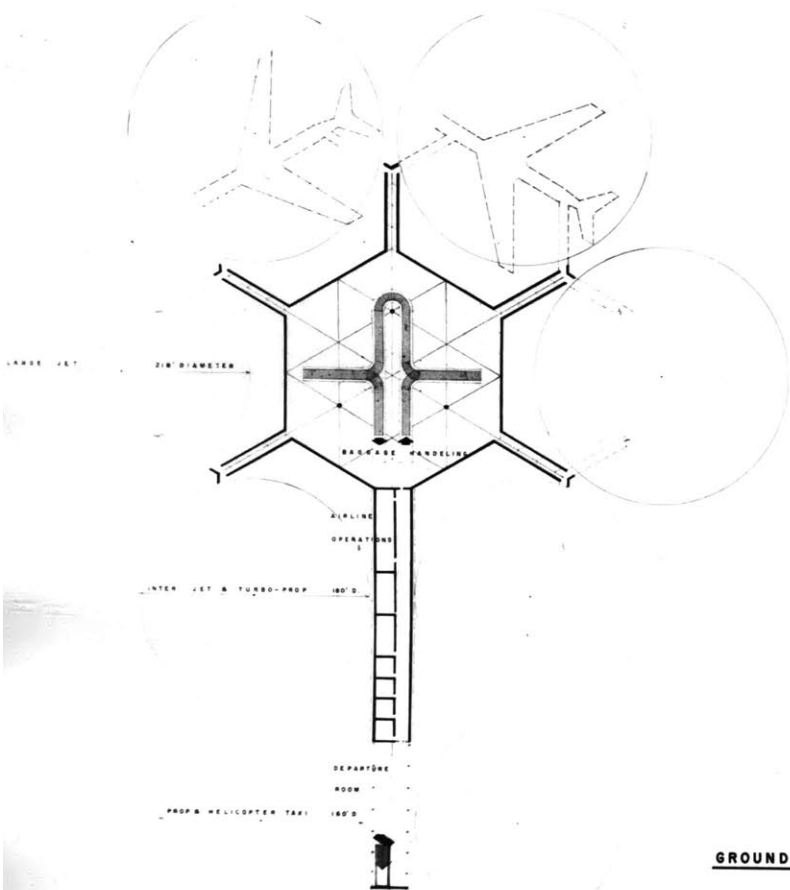


ARRIVAL LEVEL

GROUND FLOOR

Scale 1/32" = 1' 0"

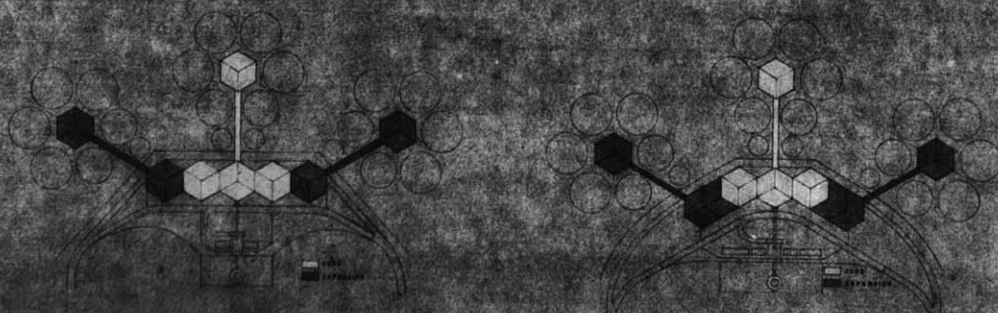


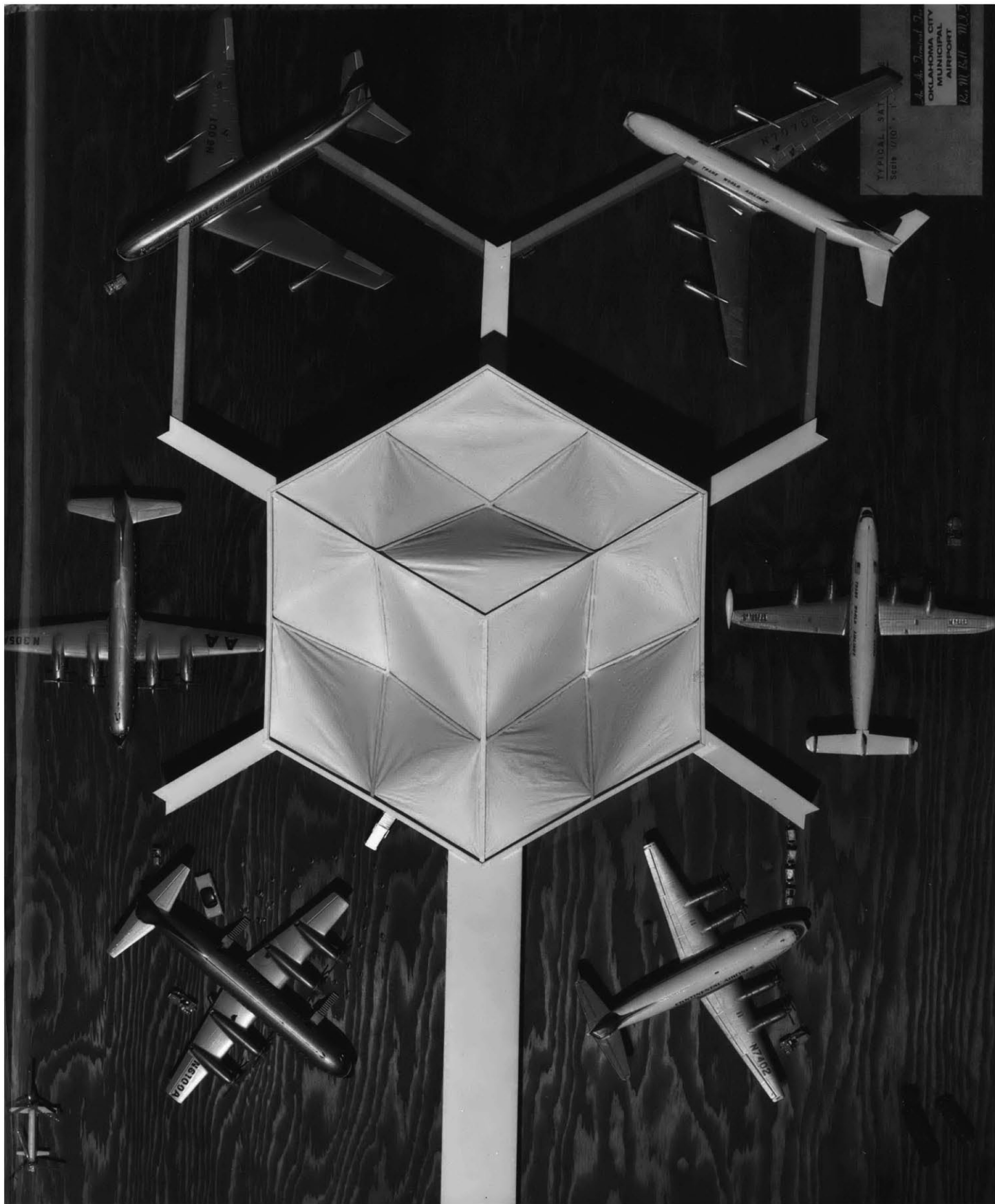


BASEMENT, CENTRAL BUILDING

Scale 1/32" = 1' - 0"

GROUND FLOOR, TYPICAL SATELLITE





1449-17
OKLAHOMA CITY
MUNICIPAL
AIRPORT
R. M. Bell 11/17

TYPICAL SAT
Seen 11/10 - 11/17

